LHC Data Interchange WG Report
User Requirements

Working Group members: H.Burckhart, A.Daneels, F.Di Maio, C.Gaspar , P.Ninin (part), P.Sollander(part), Claude-Henri Sicard(chair), D.Swoboda, E.Tsesmelis, M.Tyrrell

1.Introduction – *working group mandate*

The LHC Data Interchange working group has been established by the CERN Controls Board to investigate the needs of data interchange between machine, experiments and other services.

The first phase consists in:

- identifying systems which need to communicate
- finding what sort of data is to be exchanged
- analysing the collected information to establish User Requirements

The second phase will then develop Software requirements and investigate strategies for an implementation.

(see detailed mandate in appendix 1).

The working group has convened 10 meetings since its setting up (February 1999), and in addition collected information through many interviews and private discussions by the different members of the working group.

This note reports on the results of the first phase of the work.

2.Scope of the work

All CERN systems at CERN which are capable to exchange 'real-time' information through communication networks are considered in the scope of this work.
However, only the secondary Level-3 alarm system is considered in the scope, as the primary system depends only on its own sensors to gather safety information and must be able to run in a closed environment.

The initial information collection did not restrict the type of data to be exchanged.
The analysis phase concentrates on data exchangeable through standard networks.
Although the evolution in communication networks may shift somewhat the limit, the timing, interlock data or other process control data which clearly need to be exchanged through hardware channels or field-buses to guarantee availability have thus been excluded in the analysis phase.

3.Communicating Entities

An entity can be defined as a set of control systems under the responsibility of a unique (or collaborating) team.[which takes care of its internal communication].

Figure 1 shows the different entities which have been identified.
During its elaboration, we have tried to keep a balance between two possibly conflicting motivations: on one hand, minimizing the number of entities reduces the possible number of implementation and responsible teams; on the other, federating too many systems in a hierarchical way cause additional layers and thus possible sources of delays and failure.
The 'Data Interchange Bus' symbolises the uniformity of access for information exchange with any other entity.
Additional entities, not identified at present, may appear during the LHC project development, but should fit within this picture.

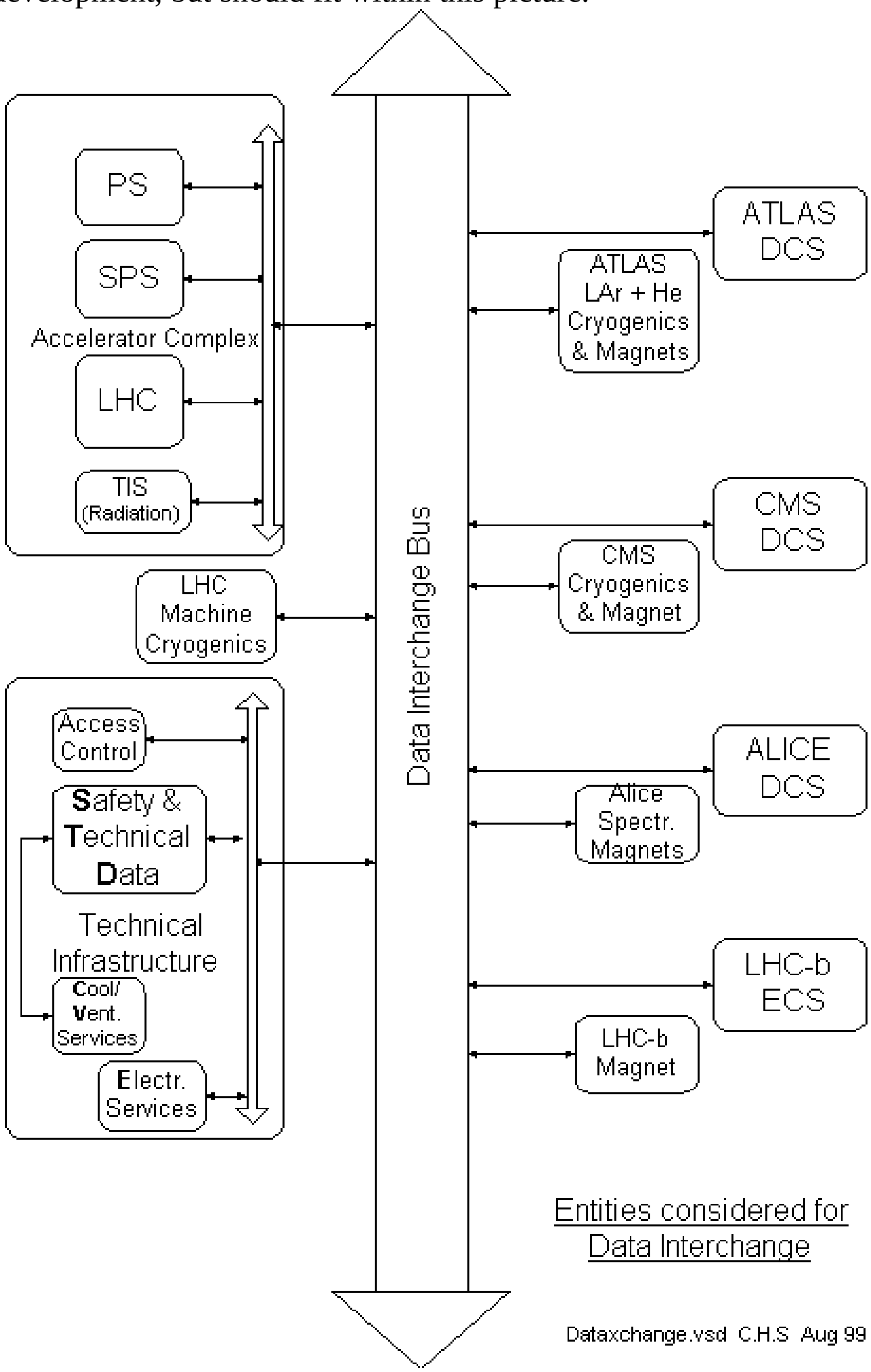

Figure 1: Entities considered for Data Interchange

<u>4. Information collected for LHC:</u> data exchanged between the different entities.

a) The data collection has been made through different interviews made by members of the working group, from existing information (LEP) and expected extrapolation for the case of LHC. Results have been collected in a single list (see appendix 3).

b) This raw information has then been filtered to keep only the data relevant for further analysis (excluding data exchanged between subsystems of the same entity, and data not to be exchanged through general-purpose networks in digital form).
From this reduced list, we show below a summary of data items, grouped by contents [table 1], and an estimate of associated synthetic figures for the bandwidth required [table 2 and figure 2] (derived from sum[polling rate*size] + estimation for asynchronous data).

Although the collected list is not expected to be exhaustive, the tables and histogram show that the individual communication bandwidths[1] can easily be handled by present-day communication infrastructures.
Most of the data is acquisition, but some systems require the sending of commands.

Alarms, as collected now by the Central Alarm Server (CAS), are included in this list [2].

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[1] To calculate the estimated bandwidths, we assumed that each data item transferred also contains a time-stamp and a quality attribute, in addition to a protocol overhead.

[2] Alarms,warnings or fault states (FS) are data which can be exchanged as any other data.
In the present CERN context, distributed software gathers, conditions and analyse these FS before passing them to a Central Alarm Server (CAS) which distributes them to dedicated alarm consoles.
Here we assume that FS are pieces of information published as any other information and to which any user may subscribe. The possible presence of intermediate entities such as the CAS or analysis Treatment does not fundamentally change this.
> In the case of FS, the amount/rate of information transmitted is hard to evaluate because of:
-irregular rate (nothing if no FS, burst if large incident)

\provider \ client \	Accelerator complex provides ▼	Experiments provide ▼	Technical, Electrical services & safety	Machine Cryogenics provide ▼	Others
Accele-rators	------------	Experiment status, beam dump request, injection inhibit, spectrometer current, detector backgrounds (summary + detailed), luminosity, vertex position, beam position, event info	Cooling water status/values, ventilation, LVL3 personnel safety Electricity status & consumption	Helium T^0, level, xfer line , current leads Cryo insulation	Quench detector /heater /supply Machine interlock, personnel access state Radiation level / status Exp.magnet state/current Survey dipole/quad positions
Experiments	Machine &operation state; Equipment: RF voltage, status,Qs, Vacuum gauges, valves, Power convertor beta values, settings; Beam Instr: beam loss, beam current (total/bunch), energy, position, sizes, collimator settings, luminosity, position of low-beta quads, absorbers. SPS beam intensity (in filling mode)	To the other experiments: Experiment status, beam dump request, spectrometer current, detector backgrounds (summary + detailed), luminosity, positions of mechanical devices	Cooling water status/values, ventilation, gas levels, safety LVL3 actions & active problems Electrical distribution status; circuit breaker actions, UPS status	------------	Exp.magnet state/current; Experiment Cryogenics status & values (if applicable)
Technical services	Machine status; control & network alarms Machine Vacuum	Experiment status & alarms	------------	Cryo. alarms	Experiment Cryo. alarms
Machine Cryo.	Machine state(advance information); power convertor settings; beam current; vacuum levels	------------------	Cooling water status/values	-------------	
Exp. magnets & cryo.	Machine state	Magnet commands; Experiment state	Cooling water status/values		---------

Table 1: Data exchanged between entities (by content)

\provider \ client \	Accelerator complex *provides* ▼	Experiments *provides* ▼	Technical, Electrical services & safety	Machine Cryogenics *provides* ▼	Other (various)	**Total received**
Accelerators *receive* <	------------	1050	19000 [20 (EL)]	57000	13000 (magnet protect, rad, SU)	**100 KB/s**
Experiments	2200	200	2800 [1400 (EL)]	----------------	125 (Cryomagnet) 5 (SU)	**5 KB/s**
Technical services & Safety	20	100	-----------	70		**0.2 KB/s**
Machine Cryogenics	15	-----------	5	-------------	-------	**0.02 KB/s**
Exp.magnets & cryo.	5	5	5	-------------	---------	**0.02 KB/s**
Total produced	**2.2 KB/s**	**1.4 KB/s**	**23 KB/s**	**57 KB/s**	**13 KB/s**	

Table 2: Expected Bandwidth exchanged between entities (Bytes/second)

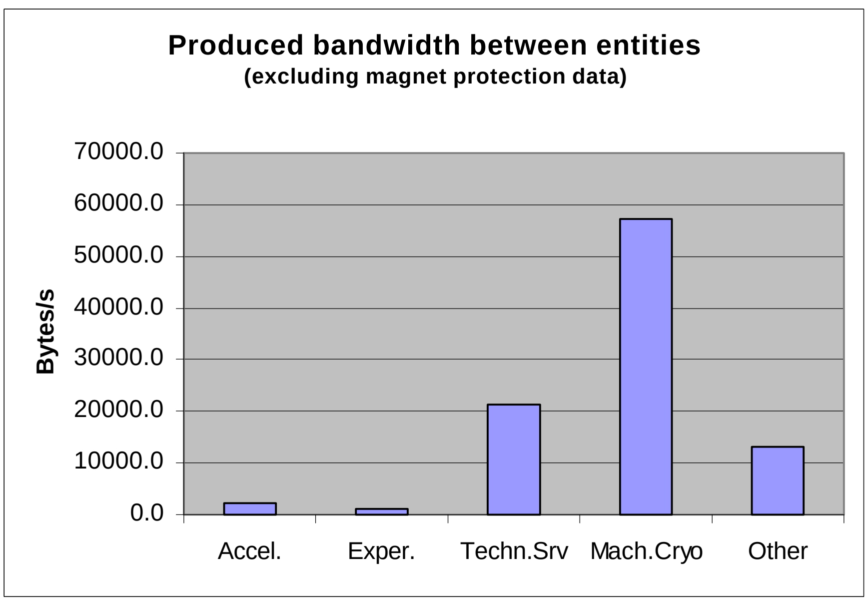


Figure 2: Produced bandwidth

5. User requirements for a data exchange mechanism

From the above information, and from additional input during the interviews, the following list of user requirements is proposed (*in italics, the motivations behind each requirement)*:

Uniformity:

1. The same protocol shall be used to communicate data with all the different external entities.

Availability:

2. For technical services in TCR and some parts of cryogenics, basic service will be scheduled to run 24h/day, 365days/year.
3. Unscheduled loss of service should not exceed 5 minutes.

Reliability:

4. Clients must be made aware if a data source does not update its information to the outside (could be done by time-stamping the data).
5. The data publisher must ensure that clients are informed if the data source is not working.

Synchronisation:

6. Time stamping of the data with millisecond resolution is needed, with an overall (inter-system) precision of 0.1sec, to allow event correlation. (This implies that all connected computers use the standard time servers to keep their clocks synchronized)

Latency:

7. Acceptable delay between a value change and its availability at the client level should not exceed 1 second under normal traffic conditions.

Performance:

8. The 'databus' must be able to handle a peak traffic of 250 KBytes/s and 100 messages/s without loss of data – note that reliability is more important than performance.

Adaptability:

9. An entity should be able to subscribe and receive new data from another entity without needing any static configuration change at the producer level.

Protocol features:

10. select commonly-used industrial interface standards, in particular to minimize integration work for externally provided systems.
11. Protocol must run on multiple platforms (Unix [several variants], Windows-NT)
12. an 'on-change' communication mode is required, due to the large amount of information to be monitored which changes only rarely.
13. Grouping multiple changes occuring in same time-slot (wakeup client only once) *motivation: optimize performance*
14. Only 'current' values are to be considered (no historical data) *motivation: for simplicity, but leave possibility open for future*
15. Clients should be able to browse for information on published data items (list of items, data format, update period,…).
16. Naming scheme should be uniform.

Constraints: Any use of the above mechanism should not exceed the following limits:

17. Client communication message rate required with another entity will not exceed 10 messages/second. (*motivation:give maximum bound on system sollicitation)*
18. Client shall not expect a latency better than 0.5 second from the source event.

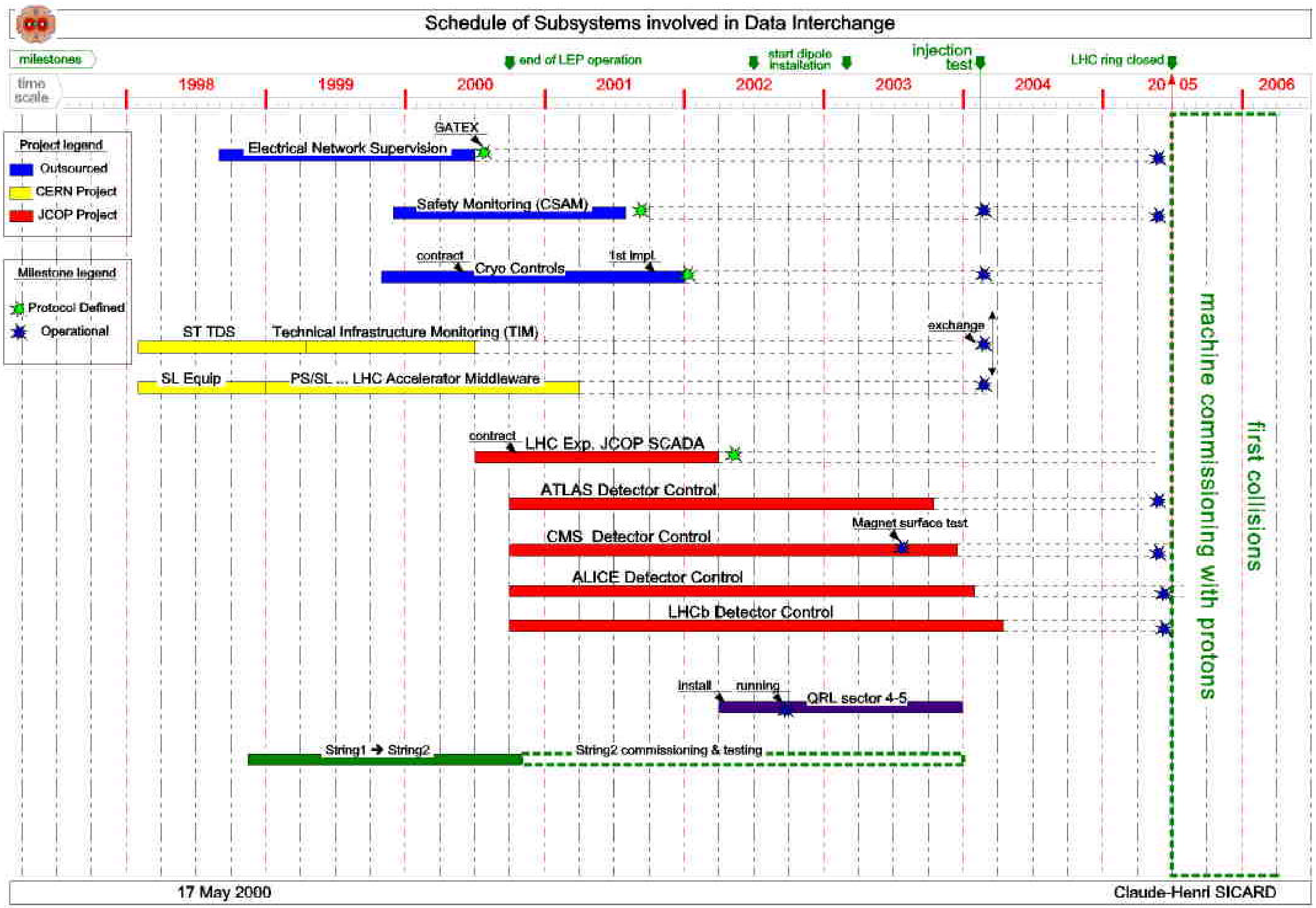
6. Conclusions.

- A first analysis of the collected data shows that current communication infrastructure can easily handle the bandwidth needs. The main data flow is directed towards the LHC accelerator, mostly from accelerator sub-systems, but messages flow in all directions.
- Another important aspect is that a large part of the data is asynchronous in nature, i.e. changes only rarely and that a simple polling mechanism would be very inefficient.
- To ensure a good acceptance of this exchange mechanism, reliability and ease of adaptation (to changes in information provided) are the two most critical aspects.
- In terms of implementation, the principal characteristic is that it must be implemented in several different contexts:
  -industry-provided complete systems such as electrical network and cryogenics,
  -integration in new commercial off-the-shelf products (Experiment JCOP)
  -existing CERN contexts, each with its own history and evolution projects (accelerators, technical services)

One must also keep in mind the uncertainty and incompleteness of the information collected, due to the long time remaining until LHC machine starts.

Continuation of work (Phase 2) should elaborate software requirements in close collaboration with existing projects at CERN (Accelerator Middleware, Experiments JCOP, Technical Services Safety project), not forgetting outsourced implementations (Electrical distribution, Cryogenics controls).
We suggest that the team should be composed of 4 or 5 people directly involved in the above projects.

<u>Milestones</u>
The following schedule synthetises the dates at which such a system needs:
(a) to be defined, in particular with respect to external contracts
(b) to be operational.
One should also plan validation of the communication early enough between different implementations, for example during subsystem tests involving several partners.
In view of the different milestones, we recommend that the software requirements should be established for 1st quarter 2001.



Schedule of Subsystems involved in Data Interchange
milestones
end of LEP operation
start dipole installation
injection test
LHC ring closed
time scale
1998
1999
2000
2001
2002
2003
2004
2005
2006
Project legend
Outsourced
CERN Project
JCOP Project
Milestone legend
Protocol Defined
Operational
GATEX
Electrical Network Supervision
Safety Monitoring (CSAM)
contract
Cryo Controls
1st impl.
ST TDS
Technical Infrastructure Monitoring (TIM)
exchange
SL Equip
PS/SL ... LHC Accelerator Middleware
contract
LHC Exp. JCOP SCADA
ATLAS Detector Control
Magnet surface test
CMS Detector Control
ALICE Detector Control
LHCb Detector Control
install
running
QRL sector 4-5
String1 → String2
String2 commissioning & testing
machine commissioning with protons
first collisions
17 May 2000
Claude-Henri SICARD

Appendix 1-Working group Mandate

Background

During operation of the LHC machine and experiments various autonomous, or semi-autonomous, systems will need to exchange data. These are primarily the accelerator complex itself, the experiments, technical infrastructure and, the Level Three Safety system. Note that technical infrastructure includes, but is not restricted to, power distribution, cooling and ventilation, environment control and technical alarms at all levels. Additional items, such as the experiments' cryogenic magnets, may also need to be considered.

Unless it really proves too complex a task, it would seem advisable to attempt to define a single message passing communications system which could be used in all these cases. This principle was unanimously endorsed at the meeting of the Controls Board on October 1st, 1998.

Mandate

The task of the working group should be divided into two phases as follows:

Phase 1: Requirements

- Make a complete list of all sub-systems which might need to communicate and identify a contact person for each one.

- Where possible, for each sub-system:
  (1) Identify the other systems with which communication is necessary.
  (2) Is the communication uni- or bi-directional?
  (3) Estimate the amount of data which needs to be transmitted each way.
  (4) Estimate the frequency of updates (bandwidth) and allowable latency.
  (5) What types of data should be transmitted? Do these include arrays, structures and so forth?
  (6) Find out if data should be sent synchronously, on request, on a change (event driven) or if any other special circumstances apply.
  (7) Identify any other constraints, such as which computer hardware and operating systems would need to be supported.
  (8) Identify all consequences of system failure, as well as the allowable down time (both scheduled and through a fault).

- Analyse the information collected in order to ensure that the requirements are broadly compatible and that indeed the implementation of a single mechanism would be feasible.

- Agree with those people responsible by which dates each of the above communications paths should be operational. This information may then be used to define a set of milestones for Phase 2.

It is clear that estimates made at this stage will certainly be revised in the future. However, they should be sufficient to define the order of magnitude of what will be needed. Input should also be obtained from those
people concerned with the equivalent problem from the LEP era.

Phase 2: Solutions

Based on the User Requirements from Phase 1, develop a set of Software Requirements and investigate strategies for an implementation. A primary question to address is whether a standard commercial solution is available or whether the work should be out-sourced or developed in-house. In the first two cases a tendering operation would be necessary, whilst the last one would need to identify those staff who would do the work. In either case it would be essential to ensure the the system could be maintained over the
lifetime of LHC.
Further issues to address might include questions such as publish/subscribe, polling and events, data buffering, data formats and encoding, definition of the application program interface (API) and the provision of test software.

N.B. Several of the communicating systems will require internally their own private communications systems. In order that the solution to the current problem is not over constrained, it should not be a requirement that the working group adopt one of these private communications systems.

W.G. Composition
The Working Group should have a delegate from each of the areas concerned, with the possibility to co-opt additional members with particular expertise if this is necessary. The composition of the W.G. must be agreed by the Controls Board which should appoint one of the W.G. members as the chairman.

Reporting and Milestones
The chairman of the W.G. should report to the Controls Board. The first milestone would be at the completion of the requirements phase, which should be within three months of the establishment of the group. Further milestones must be defined on the basis of the information acquired in the first phase.

Appendix 2 - Background & Past experience

LEP
The Data exchange between machine and experiments, after a first version based on RPC tables, uses an Oracle Data-Base, with 3 main sources:
1. Lep measurement db;
2. Lep logging db; (has also certain prepared VIEWS of data)
3. Lep production db;
To avoid polling all tables, an alert monitor registers interest in a set of tables. It waits for alerts to be fired on any of these tables and then updates an entry in a Timestamp_Table.
This mechanism works reasonably well but is rather slow (latency of tens of seconds) and client is not informed if the publisher task crashes.
Experiment view: Oracle information refresh time about 1 min, is considered OK. For alarms, there is need for faster rate (10sec), no client wake-up exists (still needs polling an Oracle table giving what's new).
Other exchange channels (e.g with Technical services) used the LEP ECA / PCA architecture for LEP machine. Few exchanges (if any) exist between Technical services and Experiments. (Experiment GSS system only sends alarms to the Central Alarm Server).

UA2 at the SppbarS Collider

The exchange of data between the UA2 experiment and the SppbarS Collider was not extensive and was concentrated on the following information:

o The bunch intensity as measured using directional couplers - pick-up antennae sensitive to single bunches. The information was used to check for missing and low-intensity bunches and it triggered the experiment gates.

o The luminosity as measured from information provided by the UA2 Luminosity Counters - an array of four scintillator counters positioned at +- 9989 mm and +- 8151 mm from the interaction point. The luminosity was extracted by using the measurement of sigma_visible, based on the measurement of σ_tot by UA2 and on the ratio of σ_elastic to σ_tot and σ_single diffractive by UA4, and N_LR, the mean rate of coincidence between beam-beam signals in the Luminosity Counters on either side of the interaction point.

o The backgrounds - beam halo and beam-gas interactions - as measured by using the coincidence in time of hits in the UA2 Time-of-Flight (TOF) detector, consisting of six scintillator counters at +- 1.2 m from the interaction point.

o The TOF counters could also measure the longitudinal vertex position. Such information was used by the Collider to optimise the RF phase. The interaction vertex in the transverse plane was found to be stable (~ 200 um.) and was not monitored continuously.

o The Collider supplied the experiment on the so-called `Page-1' with information on the bunch intensity as measured by the machine, the magnetic field and current of the magnets and with comments from the operators.

No additional information, e.g. on separator, magnet or collimator settings, nor a dump interlock were available.

In conclusion, the UA2 experiment, compared to the case at LEP, had a relatively small amount of data exchange with the machine.

Appendix 3 – List of Data Items exchanged

Glossary: Users and Providers: **LM**= LHC Machine; **SP**=SPS accel.; **PS**=PS accel.; **EX**=Experiments; **TS**=Technical Services; **CR**=Machine Cryo; **EC**=Experiment Cryo; **EM**=Experiment Magnets; **CA**=Access Control; **RD**=Radiation Protection; **SU**=Survey; **MP**=Magnet Protection; **P-Vol**=Produced volume (Bytes); **P-rate**=Producer rate; **C-Vol**=Consumer volume (Bytes); **C-rate**=Consumer rate; **Lcy**= consumer acceptable latency for asynchronous data.

EX->LM

	Equipment	Data type	P-Vol	P-rate	C-Vol	C-rate	Lcy	User	Remarks	srce
Experiments	status		4		4	A	5	LM	ready, not_ready, etc	EX
Experiments	interlock, ready for beam	Y/N	4		4	1		LM	inhibit injection if false	EX
Experiments	interlock ask beam dump		4		4	A	2	LM	CMS would have the permission to dump beam	EX
Experiments	interlock abnormal cond.		4		4	A	2	LM	CMS (for protection)	EX
Experiments	spectrometer	current	16	10 sec	16	10		LM	CMS	EX
Experiments	spectrometer	status	80	10 sec	80	60		LM	detailed magnet state description	EX
Experiments	spectrometer	polarity	16	min	16	60		LM		EX
ATL Si Tracker	detailed backgrounds	protons	40	10 sec	40	10		LM	spatial distr+ temporal struct.	EX
ATL Lar Calorimeter	detailed backgrounds	protons	40	10 sec	40	10		LM	spatial distr+ temporal struct.	EX
ATL Fwd detector	detailed backgrounds	protons	40	10 sec	40	10		LM	spatial distr+ temporal struct.	EX
ATL Muon Chambers	detailed backgrounds	protons	40	10 sec	40	10		LM	spatial distr+ temporal struct.	EX
CMS subdetectors	detailed backgrounds	protons	40		40	10		LM	define figure of merit/scale	EX
Experiments	background summary	diff.types	2*n*expt.		64	60		LM	from all exp.,/background type	EX
Experiments	instantaneous luminosity	beam	n*expt.		32	1		LM	from multiple devices (eg calorimeter[CMS])	EX
Experiments	integrated luminosity	beam	n*expt.		32	60		LM		EX
Experiments	summary luminosity	beam	n*expt.		32	1		LM	from all 4 exp.	EX
Experiments	radiation	protons	n*expt.		32	1		LM	radiation detectors / all 4 exp.	EX
Experiments	vertex	position	n*expt.		32	60		LM	could aid accel.operation by inferring machine parameters	EX
Experiments	vertex	distribution	n*expt.		32	60		LM	ATL	EX
Experiments	beam characteristics	position	2*n*expt.		64	1		LM	tilt, crossing angles	EX
Experiments	event information	display	n*expt		32	?		LM	display (video??)	EX
Experiments	compensation	current	96		96	60		LM		EX

ATLAS	solenoid	current	1	10 sec	1	60		LM	ATL	EX
ATLAS	solenoid	status	1	10 sec	1	60		LM	ATL	EX
Experiments	magnets	status	48	10 sec	48	60		LM		EX
CMS Fwd HCal.	luminosity monitoring					10		LM	real-time rate measurements (also read by CMS)	EX
CMS Fwd HCal.	beam collision spot	longit.posit.				10		LM	real-time meas. from Dt info	EX

EX->EX

Experiments	background summary	diff.types	2*n*expt.		64	60		EX	from other exp., /background type	EX
Experiments	summary luminosity	beam	n*expt.		32	10		EX	from all other 3 exp.	EX
Experiments	status		4		4	A	5	EX	ready, not_ready, etc	EX
Experiments	interlock, ready for beam	Y/N	4		4	1		LM	inhibit injection if false	EX
ATL Si Tracker	detailed backgrounds	protons	40	10 sec	40	10		EX	spatial distr+ temporal struct.	EX
ATL Lar Calorimeter	detailed backgrounds	protons	40	10 sec	40	10		EX	spatial distr+ temporal struct.	EX
ATL Fwd detector	detailed backgrounds	protons	40	10 sec	40	10		EX	spatial distr+ temporal struct.	EX
ATL Muon Chambers	detailed backgrounds	protons	40	10 sec	40	10		EX	spatial distr+ temporal struct.	EX
CMS subdetectors	detailed backgrounds	protons	40		40	10		EX	define figure of merit/scale	EX

LM->EX

	Equipment	Data type	P-Vol	P-rate	C-Vol	C-rate	Lcy	Users	Remarks	srce
LHC Machine	general machine	status	42	min/hr	2	A	10	EX	pp/ions; injection,filling,ramp,colliding,optim.,physics,dump, etc.	LM
LHC Machine	LHC operator comments	text	80	min/hr	80	A	30	EX	also on Page-1	LM
LHC RF	RF Units	Qs, Voltage	8		8	1		EX		LM
LHC RF	RF Units	status	32		32	1		EX	same as 400MHz cavities status???	LM
LHC Vacuum	gauges	pressure	2608	min	2608	60		EX	specific set /exper.	LM
LHC Vacuum	sector valves	position	256	sec	256	A	5	EX	specific set/expt.	LM
LHC Vacuum	sector valves	status	512	min	10	A	5	EX	specific set/expt.	LM
LHC PowConverters	beta values		8	sec	8	A	5	EX	nominal values	LM

LHC PowConverters	magnets around exp.	settings	36		36			EX	specific set /exper.[Q1-7,D1-2]	LM
LHC Beam Instr.	beam loss	analog	8000	.1sec	160	0.5		EX	specific set /exper.	LM
LHC Beam Instr.	BCT total beam current	protons	8	sec	8	1		EX	also on Page-1	LM
LHC Beam Instr.	indiv. Bunch currents	protons	8		8	1		EX	at IP (check feasibility w. 25 ns)	LM
LHC Beam Instr.	Beam energy	Gev	8		8	10		EX	ATL (various meas.)	LM
LHC Beam Instr.	2D beam pos.	mm	32		32	10		EX	2 up- &downstream BPMs, gives timing/trig	LM
LHC Beam Instr.	3D beam sizes		12	?	12	10		EX	emittance and beta function	LM
LHC Beam Instr.	collimators around exp.	settings			80	A	5	EX	specific set /exper.	LM
LHC Beam Instr.	luminosity measurement		16	sec	16	1		EX	CMS (also meas. by exper.)	LM
SPS	SPS beam intensities							EX	required during LHC filling	SP
TAS/TAN Absorbers	position	analog	32	sec		1		EX	4 TAN(neutral beam), 4 TAS; if moveable (CMS)	LM
TAS/TAN Absorbers		status	16	sec		A	2	EX	of non-fixed shielding (CMS)	LM

LM->TS

LHC Machine	general machine	status	42	min/hr	2	A	10	TS		LM
LHC Machine	LHC operator comments	text	80	min/hr	80	A	30	EX	also on Page-1	LM

Rad->LM

	Equipment	Data type	P-Vol	P-rate	C-Vol	C-rate	Lcy	Users	Remarks	srce
Radiation	machine & expt. areas	level	12000	sec	12000	3		LM	from TIS system	RD
Radiation	machine & expt. areas	level	200	sec	200	3		PS	from TIS system	RD
Radiation	machine & expt. areas	status	200	sec	200	60		LM		RD
Radiation	machine & expt. areas	status	200	sec	200	60		PS		RD
Radiation	machine	status	20000	15 sec	4000	15		PS	X-window application from ST ~100 monitors*history of 100 pts	RD

Survey->LM

Survey	dipoles	position	4928	15min	4928	900		LM		SU
Survey	quadrupoles	position	1600	15min	1600	900		LM		SU

Survey	low beta quadrupoles	position	96	15min	96	900		LM	(6/expt.)	SU
	TS->LM									
Technical services	cooling water	status	600		600	A	20	LM		TS
Technical services	cooling water	status	100		100	A	20	PS		TS
Technical services	ventilation	status	200		200	60		LM		TS
Technical services	electricity/consumption	status	100		100	5		LM		TS
Technical services	electricity/consumption	status	100		100	5		PS		TS
Interlocks	access control	digital	10/zone		500	A	5	PS	beam stoppers + vetos	CA
Access Control	Machine Interlock System	status	15000	sec	15000	A	5	LM	MIS:total 30KB, (LEP case)	CA
Access Control	Personnal access	status	15000	sec	15000	A	5	LM	total 30KB, (LEP case)	CA
	TS->EX									
Technical services	cooling water	analog	40		40	10		EX	ATL	TS
Technical services	ventilation	status	20		20	60		EX		TS
Technical services	cooling water	status	10		10	A	20	EX		TS
Technical services	electrical distribution	status			200	A	5	EX		TS
Technical services	circuit breakers actions	actions			2000	A	5	EX	ATL	TS
Technical services	UPS status	status			100	A	5	EX	ATL	TS
Technical services	Gas	levels			200	20		EX	CMS	TS
Technical services	LVL3 safety	actions			1000	A	5	EX	taken or foreseen (ATL)	TS
Technical services	LVL3 safety	active pbs			1000	A	5	EX		TS
Access Control	Personnal access	status	100	sec	100	A	5	EX	experiment access status	CA
	CR->LM									
	Equipment	**Data type**	**P-Vol**	**P-rate**	**C-Vol**	**C-rate**	**Lcy**	**Users**	**Remarks**	**srce**
LHC Mach.Cryo.	insulation	temperature	13400	sec	13400	5		LM	5 local control rooms & 1 central - a complete control system	CR
LHC Mach.Cryo.	insulation, PT/He level	level	13400	sec	13400	5		LM		CR
LHC Mach.Cryo.	insulation	status	6700	sec	6700	A	3	LM		CR

LHC Mach.Cryo.	beam	temperature	13400	sec	13400	5		LM		CR
LHC Mach.Cryo.	beam, PT/He level	level	13400	sec	13400	5		LM		CR
LHC Mach.Cryo.	beam	status	6700	sec	6700	A	3	LM		CR
LHC Mach.Cryo.	transfer lines	temperature	4640	sec	4640	5		LM		CR
LHC Mach.Cryo.	transfer lines	status	464	sec	464	A	3	LM		CR
LHC Mach.Cryo.	current leads	temperature	13600	sec	13600	5		LM		CR

CR->TS

LHC Mach.Cryo.	CRYO_GENERAL_MEY	alarm(DI)	1		1	A	5	TS	from present LEP case	CR
LHC Mach.Cryo.	CRYO_GENERAL_PRE	alarm(DI)	4		4	A	5	TS		CR
LHC Mach.Cryo.	CRYO_MAGNETS_LHC	alarm(DI)	20		20	A	5	TS		CR
LHC Mach.Cryo.	CRYO_RFCAVITIES_SPS	alarm(DI)	2		2	A	5	TS		CR

LM->CR

LHC Machine	general machine	status	42	min/hr	2	A	10	TS		LM
LHC Machine	advance beam info	status	10	min/hr	2	A	10	TS		LM

Survey->EX

Survey	low beta quadrupoles	position	96	15min	24	900		EX	(6/expt.);movement of 1 um critical (CMS)	SU

Exp.Magnets&Cryo->EX

	Equipment	Data type	P-Vol	P-rate	C-Vol	C-rate	Lcy	Users	Remarks	srce
Exp. Subsystem	magnets	analog	64		64	10		EX	ATL	EM
Exp. Subsystem	magnets	commands	16		16	A	5	EX	ATL	EM
Exp. Subsystem	magnets	status	80		80	10		EX	ATL	EM
Exp. Subsystem	Cryogenics	status	80		80	10		EX	ATL	EC
Exp. Subsystem	Cryogenics	analog	some		24	60		EX	ATL	EC
Exp. Subsystem	Cryogenics	feedbk loop			24	10		EX	closed loops (ATL)	EC

	Magnet Protect.->LM									
Magnet Protection	41 PLC's * 60 magnets	status	4920	sec	4920	A	2	LM	not assigned to an entity	MP
Magnet Protection	41 PLC's * 60 magnets	values	9840	sec	9840	A	2	LM		MP
Magnet Protection	quench/associated magnet	data	27000	A	27000	A	2	LM		MP