



**MASTER
SYSTEMS**

Best Commercial (Non-defense) System of Systems Acquisition Practices

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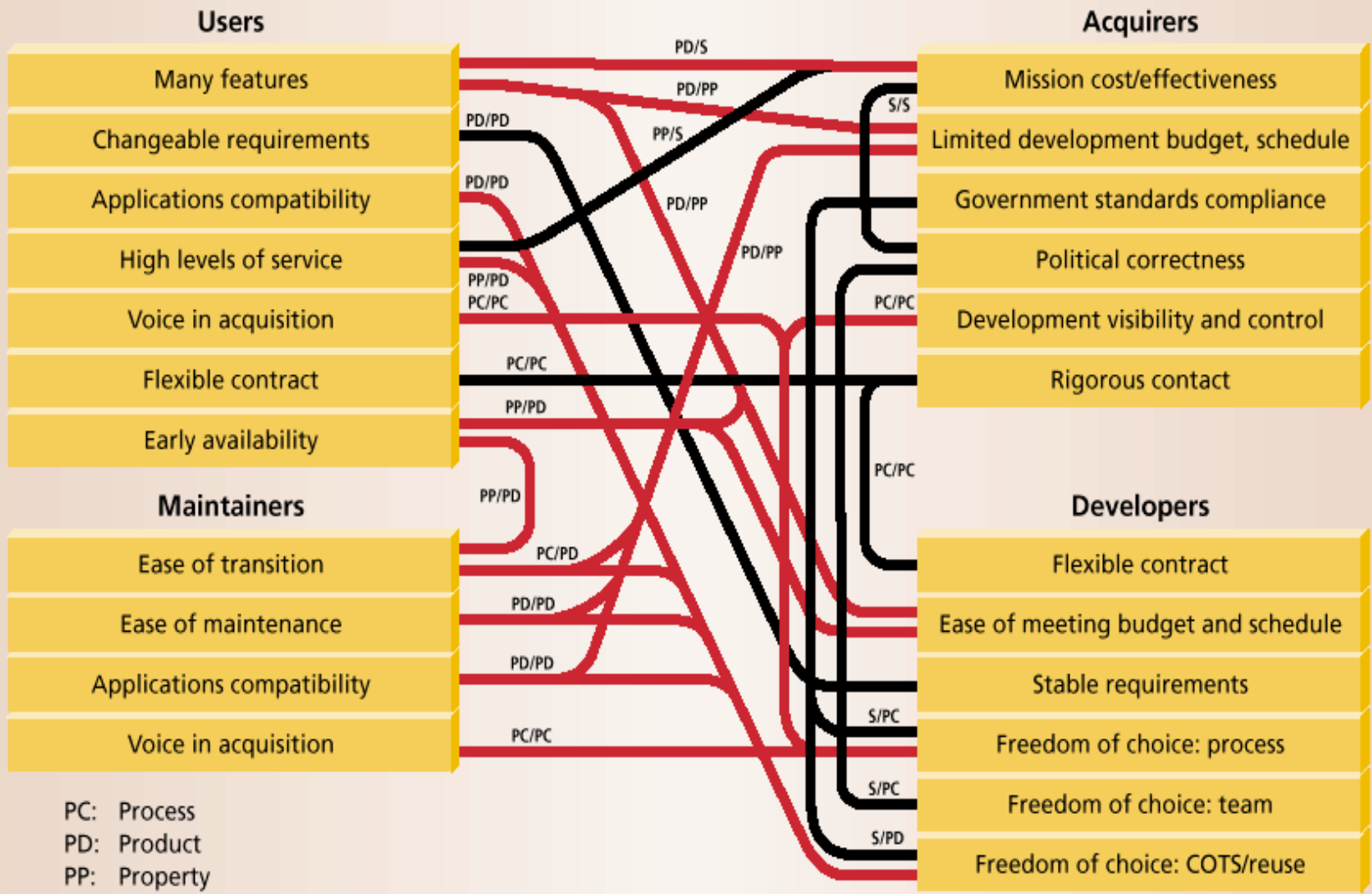
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Program & role mismatches





How is commercial different?

- Hope vs. reality = "The grass is always greener on the other side of the fence."
- Trust is the greatest challenge for government acquisition, partnerships are the most difficult to obtain.
- Trust is the greatest challenge for commercial acquisition, and partnerships are possible to obtain.
- The lack of trust is justified every day in newspaper headlines!



The biggest difference

- Knowledge of capability, even if vague vs. “Can do” attitude.
 - Government: “We must have something this big!”
 - Commercial: “We don’t think we can built something that big.”

First example: CERN

- European Organization for Nuclear Research. CERN = French Conseil Européen pour la Recherche Nucléaire, or European Council for Nuclear Research, a provisional body founded in 1952.
- Now known as "European laboratory for particle physics" ("Laboratoire européen pour la physique des particules").
- CERN conducts pure scientific research into the laws of nature, as described in the Organization's founding convention:

"The Organization shall provide for collaboration among European States in nuclear research of a pure scientific and fundamental character, and in research essentially related thereto. The Organization shall have no concern with work for military requirements and the results of its experimental and theoretical work shall be published or otherwise made generally available."

At present, its Member States are Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom. India, Israel, Japan, the Russian Federation, the United States of America, Turkey, the European Commission & Unesco have observer status.





What CERN has in common with US Defense establishment

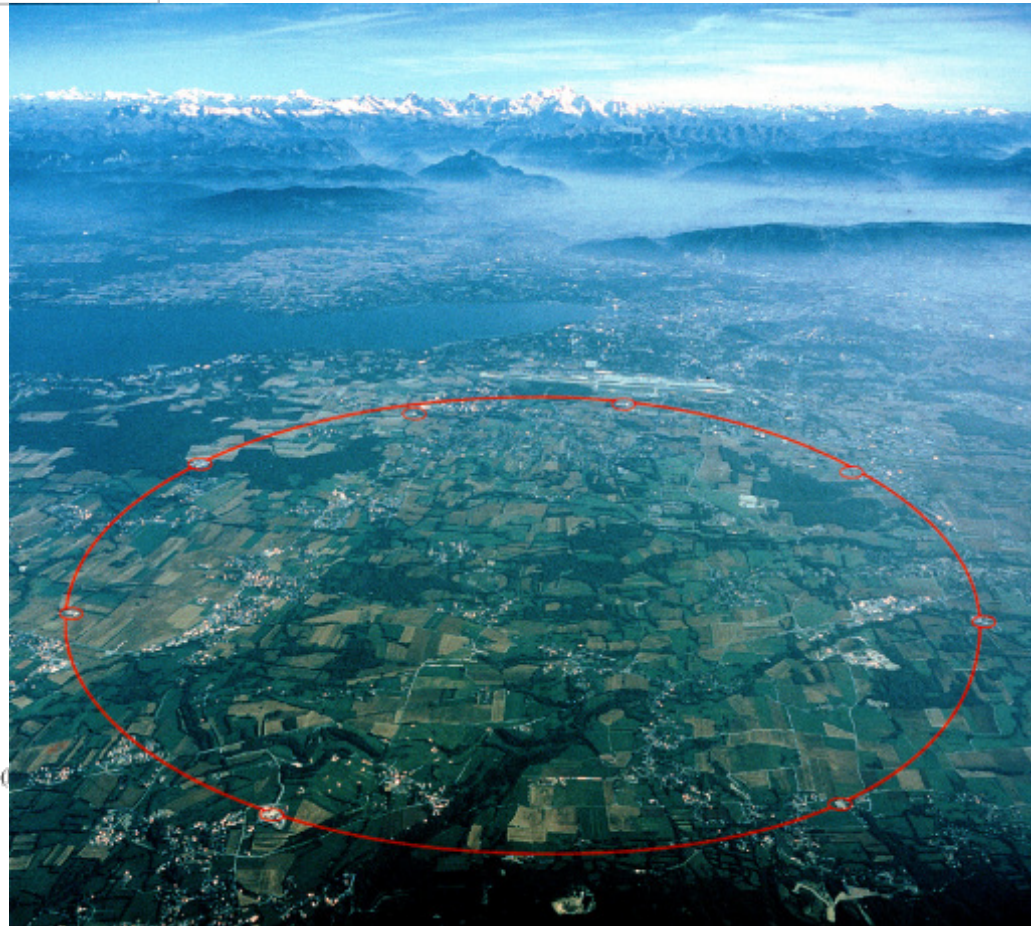
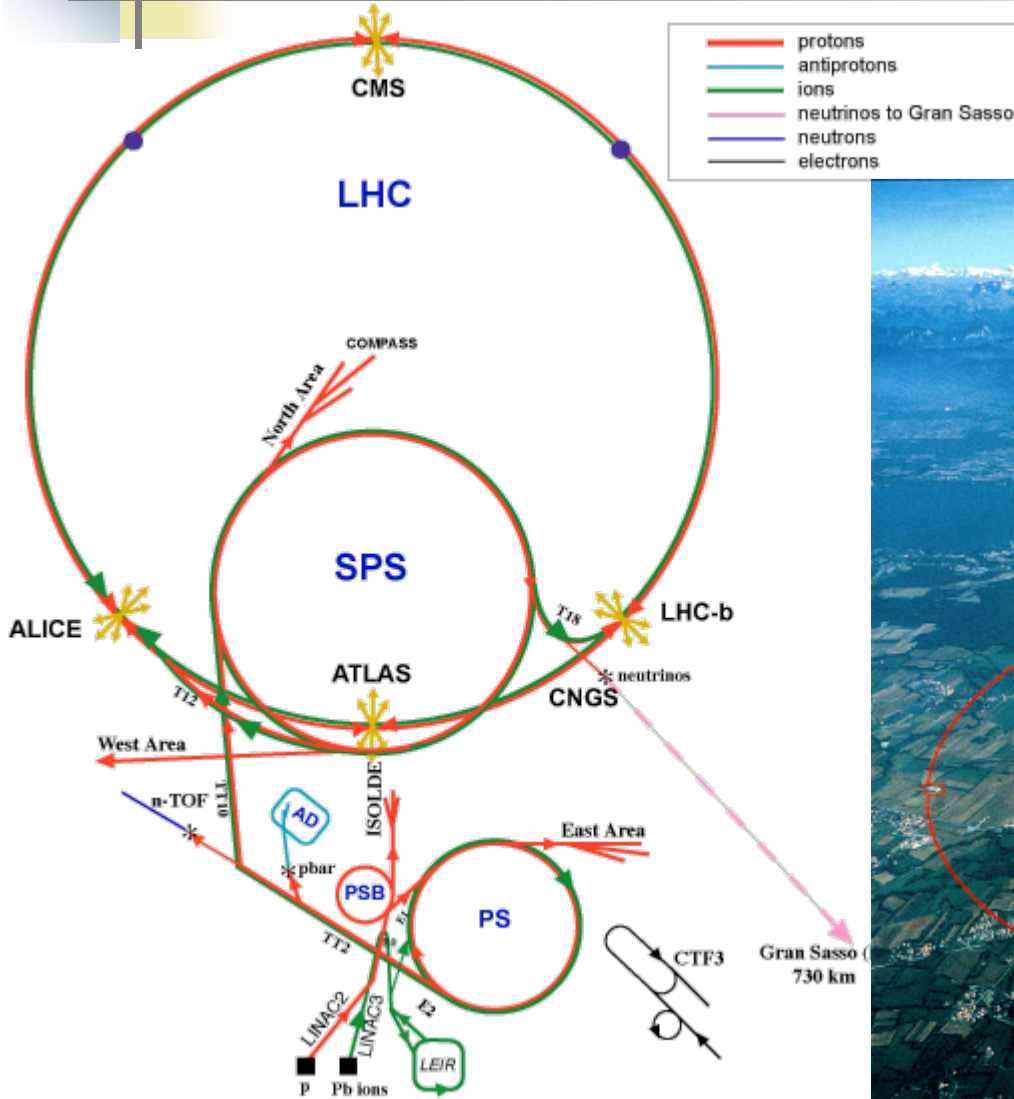
- Many, many stakeholder communities.
- Pride is valued.
- International in scope. Many different cultures represented. Many different heritages & histories, not all positive. Melting pot, uneven skills.
- Largest programs on Earth.
And many other –est's!
- Serious, goal-aligned. High team cohesion.
- Very, very expensive programs. Very long programs.
- Nothing is forever = evolution is expected.
- Always a bit of a gamble, outcomes not guaranteed.
- Epitomizes – is the definition of – emerging!



One big (subtle) difference

- Immutability is understood – and respectfully poked at.
- There are some laws that you cannot break = there are some things you cannot do.

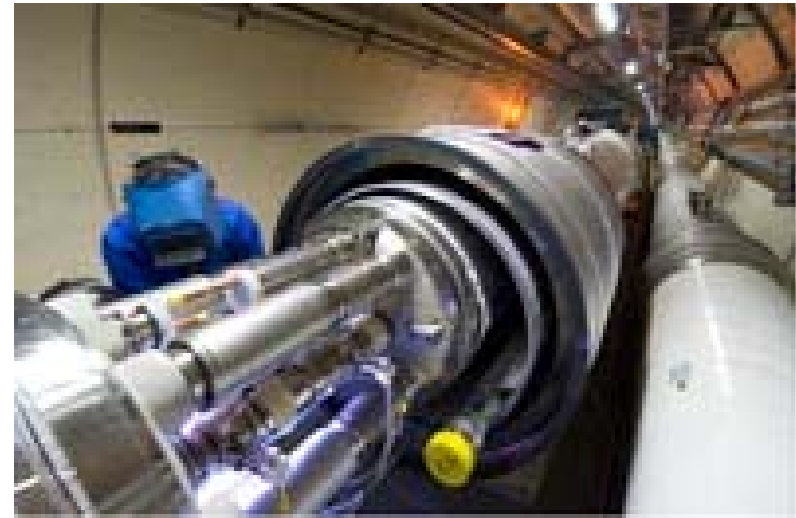
CERN accelerators



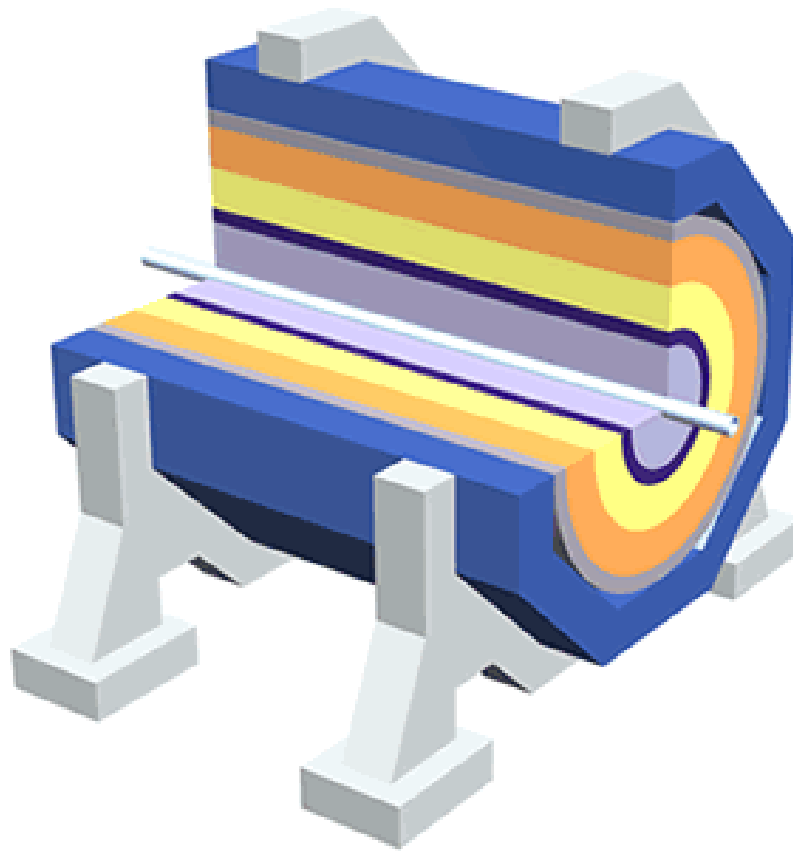
Large Hadron Collider tunnel



**27 km =
16½ mi**

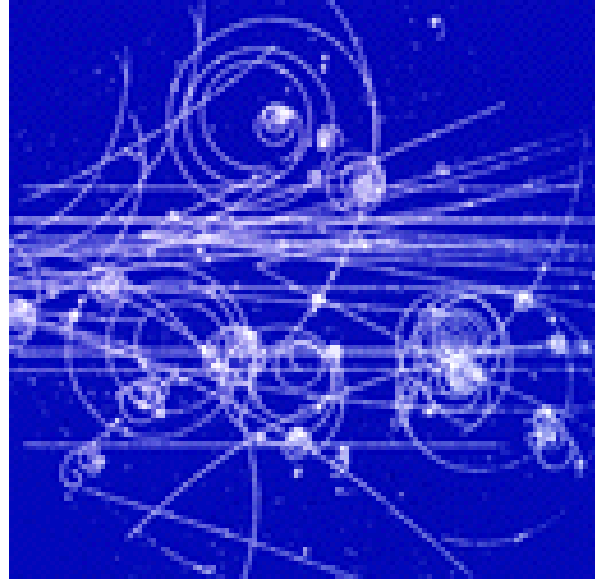


CERN detectors

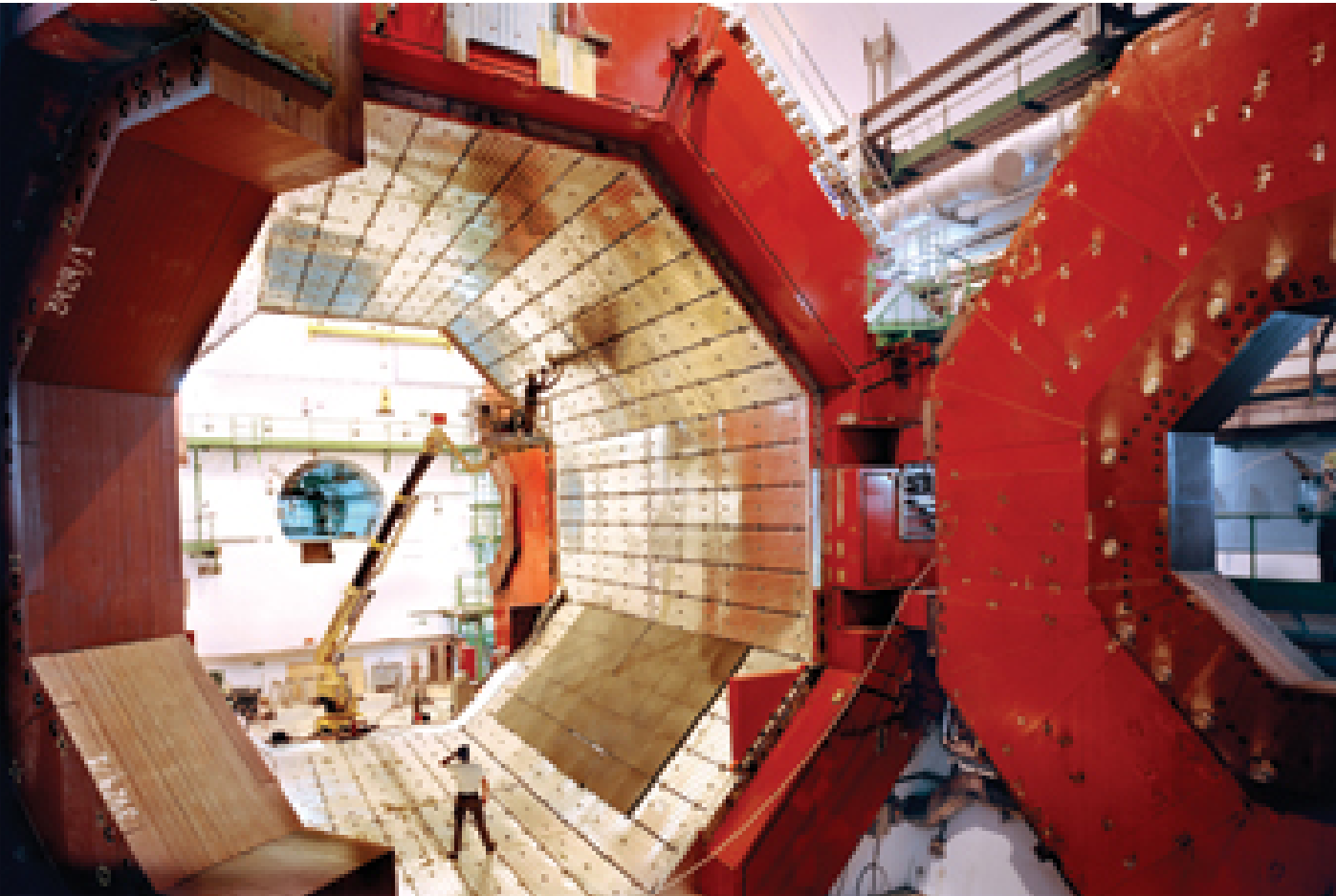


- Beam pipe
- Tracking chamber
- Magnet coil
- Electromagnetic calorimeter
- Hadron calorimeter
- Magnetise iron
- Muon detector

Tracking chamber outputs

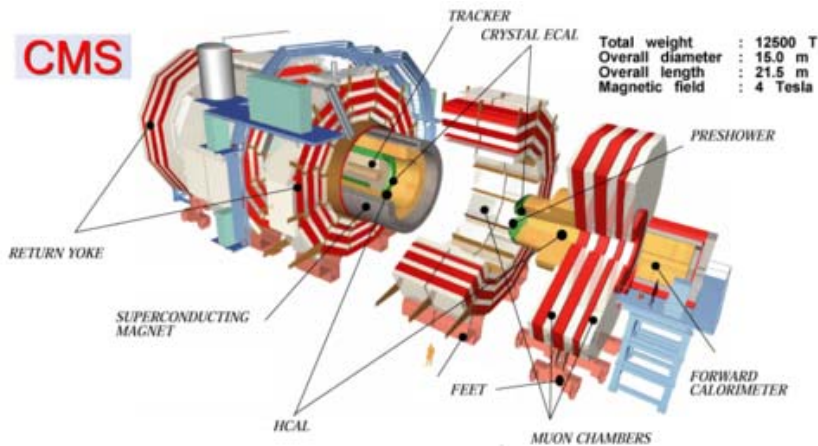


ALICE detector



ALICE -- A Large Ion Collider Experiment -- involves an international collaboration of more than 1000 physicists, engineers and technicians from 30 countries.

Compact Muon Solenoid



The CMS experiment is one of two large general-purpose particle physics detectors in the proton-proton Large Hadron Collider (LHC) at CERN. Approximately 2300 people from 159 scientific institutes form the collaboration building it.



LHCb - Experiment Studying CP Violation at the Large Hadron Collider

Institute	Current Activity
Brazil	
UFRJ	Muon detector, data handling
France	
Clermont-Ferrand	Calorimeter
Marseille	Trigger, data handling
Orsay	Calorimeter, trigger, data handling
Germany	
Humboldt	Outer tracker
Dresden	Outer tracker
Freiburg	Outer tracker
MPIK	Vertex detector
Heidelberg (Physics Institute, MPI, IHEP)	Inner tracker, trigger, data handling
Italy	
Bologna	Calorimeter
Genova	RICH detector
Milano	RICH detector
Rome (La Sapienza, Tor Vergata)	Muon detector
Cagliari	Muon detector
Rumania	
Bucharest	Calorimeter
Russia	
INR	Calorimeter
ITEP	Calorimeter
Lebedev	Calorimeter, data handling
IHEP	Calorimeter, outer tracker
PNPI	Inner tracker, muon detector
Spain	
Santiago	Inner tracker
Barcelona	Calorimeter
Switzerland	
Lausanne	Vertex detector, trigger
Ukraine	
IPT Kharkiv	Calorimeter
INR Kiev	Vertex detector
UK	
Glasgow	RICH detector
Liverpool	Vertex detector
ICSTM (London)	RICH detector
Oxford	RICH detector, data handling
Cambridge	RICH detector, data handling
RAL	
Edinburgh	RICH detector
USA	
Virginia	Trigger, muon detector
Northwestern	
Rice	Trigger
China	
Beijing	
Hefei	Muon detector
Nanjing	Muon detector
Shandong	Muon detector
Holland	
VU Amsterdam	Vertex detector, outer tracker
FOM	Vertex detector, outer tracker
Uni. Amsterdam	Outer tracker
Utrecht	Outer tracker
Finland	
Espoo-Vantaa Institute of Technology	Trigger, data handling

**565 scientists from
47 universities and
laboratories from
15 countries**

**“Why we are not made
up of anti-matter”**



How does CERN do it?

- An institution gets to participate if it agrees to ground rules:
 - Scientific purpose
 - Standards of evaluation
 - Means (not usually all of the goals)
 - Openness, sharing of results
 - Constraints on the infrastructure



... in light of ...

- Intense (scientific) competition
 - Espionage, theft, destruction.
 - Personal reputations are made, Nobel Prizes are won & lost.
 - VERY political, zero sum game.
- Many layers of interaction, not just scientific or engineering.
- No trust, not a shared definition & value for honesty. Many cultural differences.



... yields ...

- CERN has learned over the years how to stay out of fights!
- That is, fights do not add value, do not accomplish aims.
- Keeps the discourse technical! Manages by influence, not hierarchy.
- Complementary skills: making better agreements + making more detailed task descriptions. (see "Complementarity and evolution of contractual provisions: An empirical study of IT services and contracts," N. Argyres, J. Bercovitz & Kyle Mayer, *Organization Science* 18(1) 3-19, Jan-Feb 2007.)

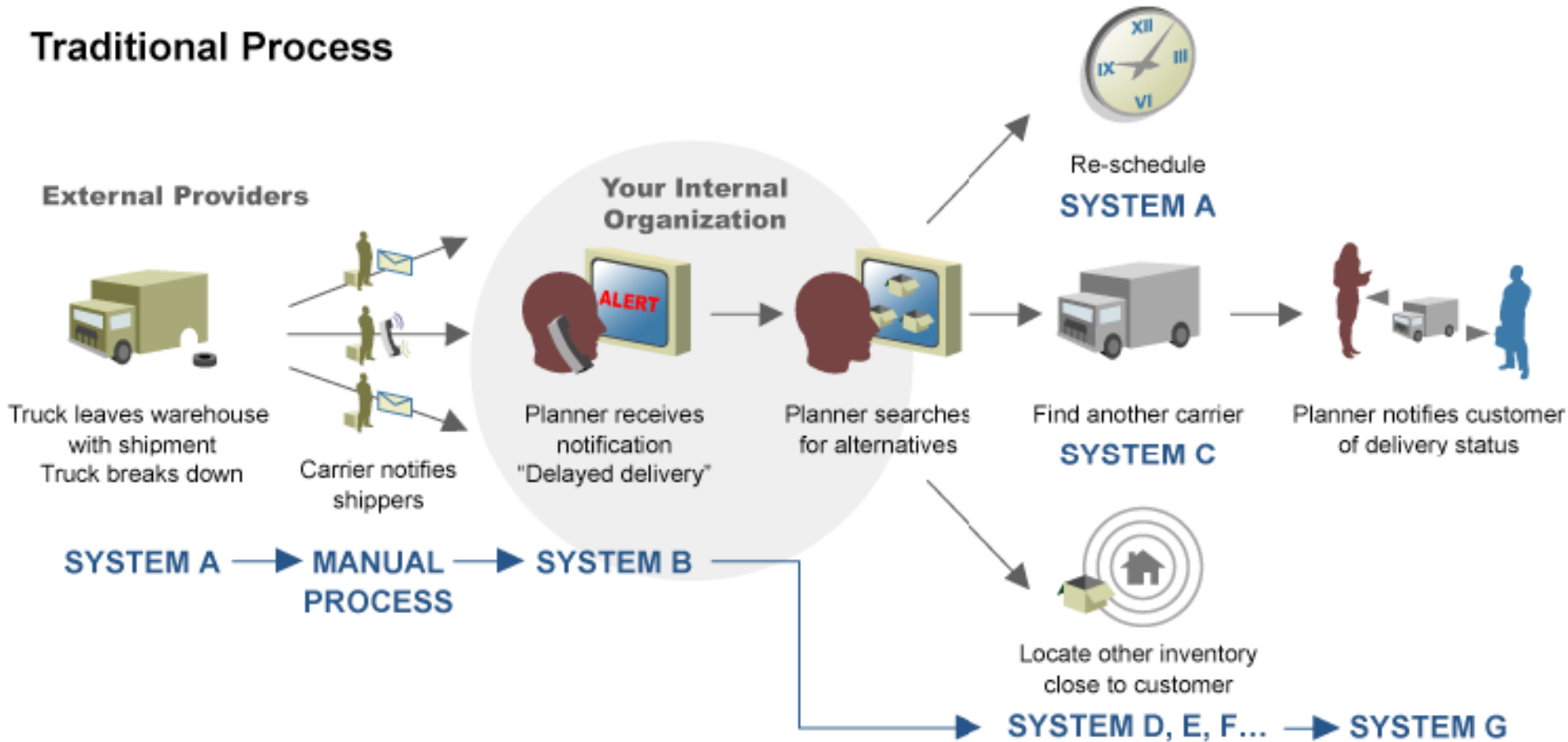


Second example (a bad one)

- Oracle Inc., a software + services provider, bought up most of its competitors & is now trying to fuse them:
 1. PeopleSoft Enterprise
 2. Oracle E-Business Suite
 3. Siebel Customer Relationship Manager
 4. JD Edwards EnterpriseOne
 5. JD Edwards World

From Oracle, part I

Traditional Process



From Oracle, part II

Next-Generation Business Process

BUSINESS INSIGHT - Monitor, Analyze, Act

External Providers

Your Internal Organization

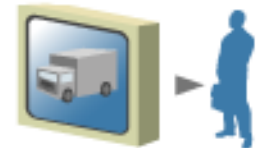
Customer



System B reschedules and finds other carrier or inventory options



Alerts planner if needed



Notifies customer of delivery status

SYSTEM A

SYSTEM B
ACCESSES SYSTEMS
A, C, D, E, F...

SYSTEM G



Architectural mismatch

- Conflicting assumptions
 - Nature of components
 - Infrastructure
 - Control model
 - Data model
 - Nature of connectors
 - Protocols
 - Data model
 - Global architectural structure
 - Construction process



Next commercial SoS disasters

- Grid computing for data intensive applications.
- US regional Bell operating companies now back as AT&T.
- Embedded automobile applications (see the Car Whisperer).

The implications are clear:

There are few examples of success, many of disaster. Acquiring Systems of Systems is a difficult problem, whether in the commercial or government sectors.