ARCHITECTURE ALTERNATIVES

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Acronyms

4D	Four-dimensional
ACC	Area Control Centre
ACI	Area of Common Interest
AM	Aircraft Derived Data Manager
AMAN	Arrival Manager
AOC	Aircraft Operation Cell or Centre
AoI	Area of Interest
AoR	Area of Responsibility
APP	Approach Control Centre
ATSU	Air Traffic Service Unit
CAP	Controller accessed parameters
CASA	Computer Aided Slot Allocation
CDM	Collaborative Decision Making
CM	Configuration Manager
CWP	Controller Working Position
DMAN	Departure Manager
EATMP	European Air Traffic Management Program

EM	Environment Manager
EOA	EATMP Overall Architecture
ETFMS	Enhanced Tactical Flow Management System
FD	Flight Data
FDP	Flight Data Processing
FLIPCY	Flight Plan Consistency
FM	Flight Manager
FMS	Flight Management System
FPL	Flight Plan
IFPP	Initial Flight Plan Processing
IFPS	Integrated IFPP System
IOP	Interoperability
MTCD	Medium Term Conflict Detection
OLDI	On Line Data Interchange
SAP	System accessed parameters
SMAN	Surface movement Manager
STCM	Short Term Conflict Manager
TACT	Tactical system

Principal References

EATMP	EUROCONTROL. Overall Architecture for EATMP. 2001
ASE	EATCHIP.Overall CNS/ATM Architecture for EATCHIP. 1997
FDPSI	FDPS Interoperability Study. 1997
FDPD	EATCHIP. Operational Requirements for Flight Data Processing and Distribution Core Functions (Area Control). 1995
EDPD	ETCHIP Operational Requirements for Environment Data Processing and Distribution. 1995
AAF	EATCHIP. Operational Requirements for ATM Added Functions. MTCD, MONA, Safety Net, AMAN.
TORCH	EEC. TORCH. Operational concept. 2000
AFAS	EEC. AFAS. Aircraft in the future ATM system. AFAS Operational Services and Environment Definition. 2001
CFMU	CFMU Development Plan.

Statement of Work

Objectives:

- **Present alternative architectures to support investigations on institutional aspects**

Approach:

- **Required capability:**
  - FD consistency across systems
  - Availability of ECAC-wide FD
- **Logical architecture: EATMP overall architecture**
- **Potential system architectures**
- **Stakeholders preferences from questionnaire and interviews**

Outcome:

- **Proposal for a convergence architecture**

The EATMP Overall Architecture (EOA)

The most advanced *common* ATM model in Europe, featuring all actors

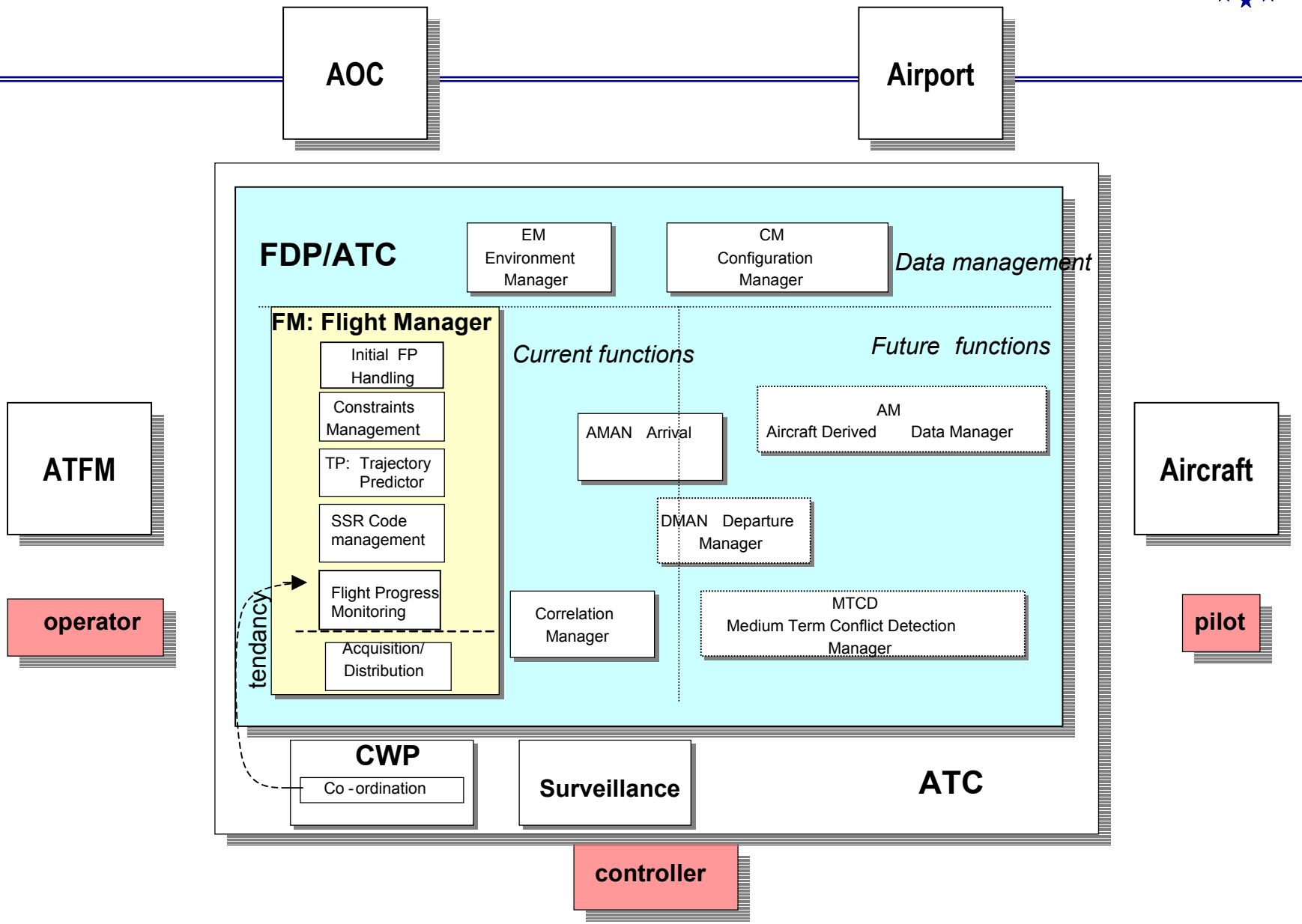
Targets the 2000-2010+ time frame

Composed of components, collected in clusters

Components of interest for this study:

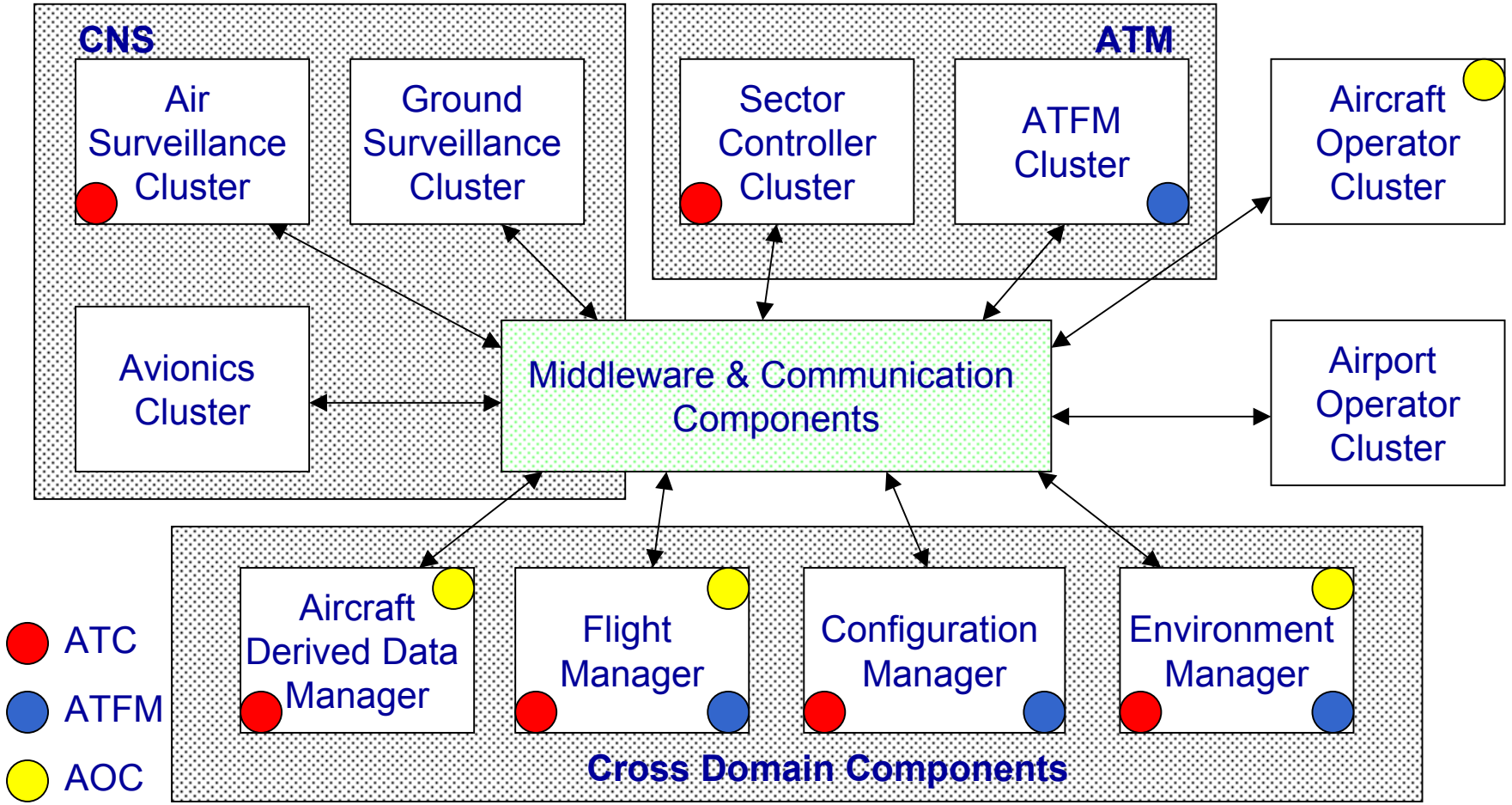
- Flight Manager (FM)
- Environment Manager (EM)
- Configuration Manager (CM)
- Aircraft Derived Data Manager (AM)
- Correlation Manager
- Arrival & Departure Managers (AMAN/DMAN)
- Medium Term Conflict Detection (MTCD)

Usual ATC FDP Definition



Adapted from: EATCHIP FDPD & EDPD, EATCHIP ASE, EATMP

EOA: The Lego™ of Future Systems



Interoperability (IOP) Protocol

Flight Data (FD): description of a flight

- **Flight script ("flight intent information")**
  - 2D navigation plan
  - Vertical profile
  - Applicable constraints (strategic & tactical)
- **4D Trajectory**

Events in the flight life cycle

- **Script update (entails new trajectory)**
- **Trajectory update based on surveillance (may entail new script)**

IOP protocol: exchange (part of) FD upon (some) event between actors (ATC, ATFM, AOC, Aircraft, Airport)

Existing & Future IOP Protocols

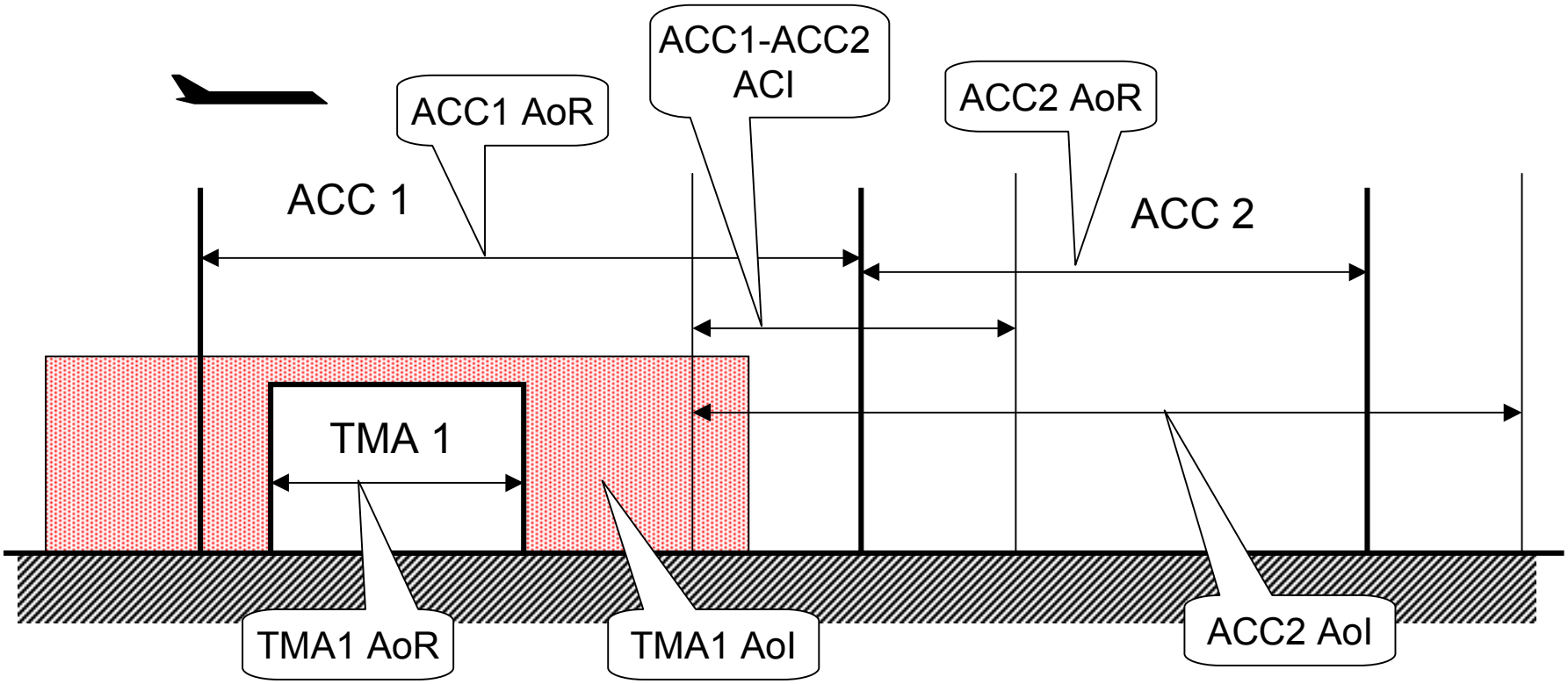
Existing:

- **Flight intent information**
  - ICAO messages
  - OLDI Co-ordination messages
  - IFPS-ATC protocol
  - TACT-ATC and TACT-AOC protocol
- **Aircraft intent information**
  - Down-linked parameters: ADS report

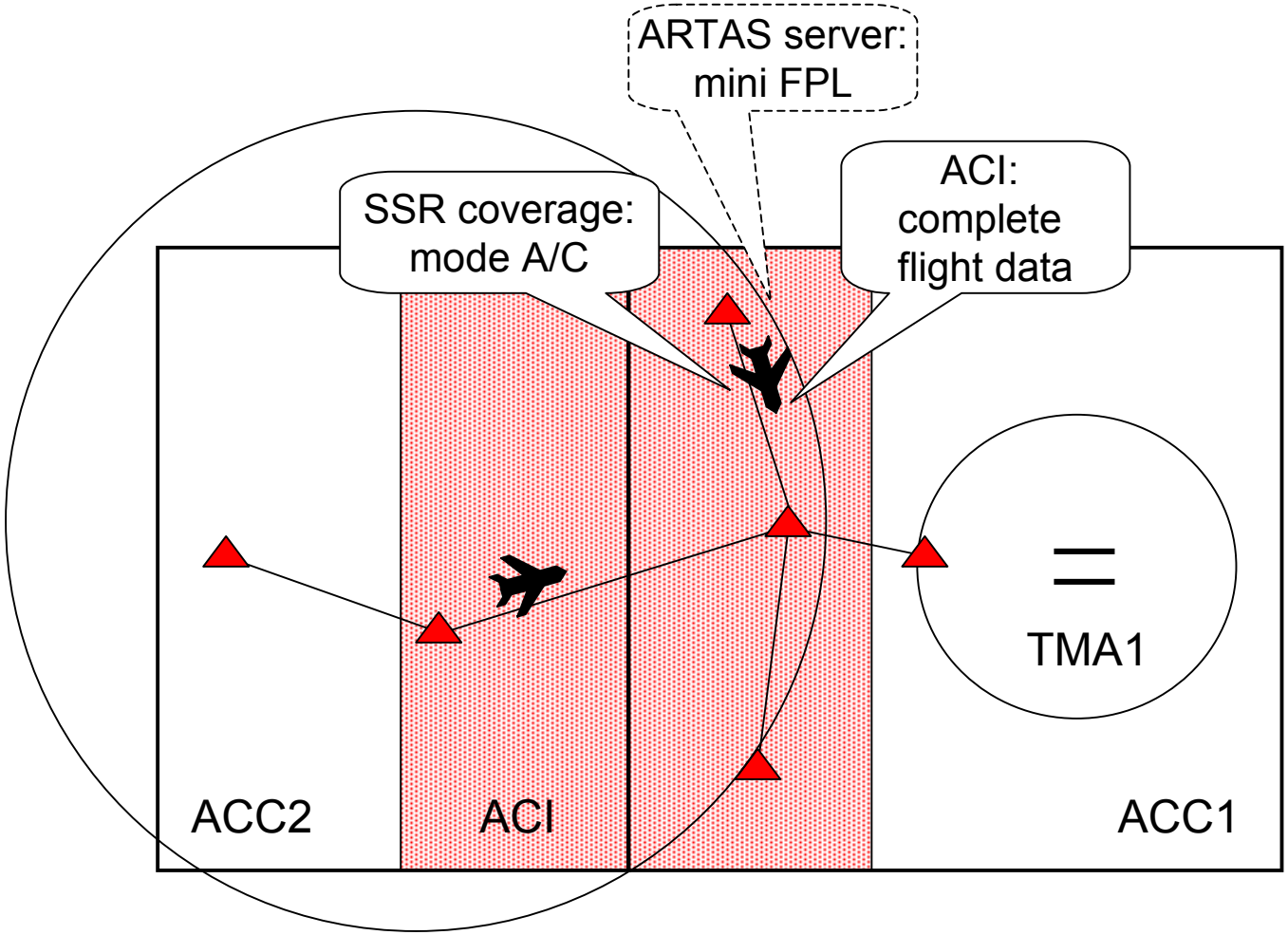
Future:

- **ETFMS-ATC protocol (imminent)**
- **ATC-ATC IOP in Area of Common Interest (ACI)**
- **Data Link: SAP, CAP, FLIPCY services**

ACI-Based IOP Protocol



Traffic Awareness in ACI



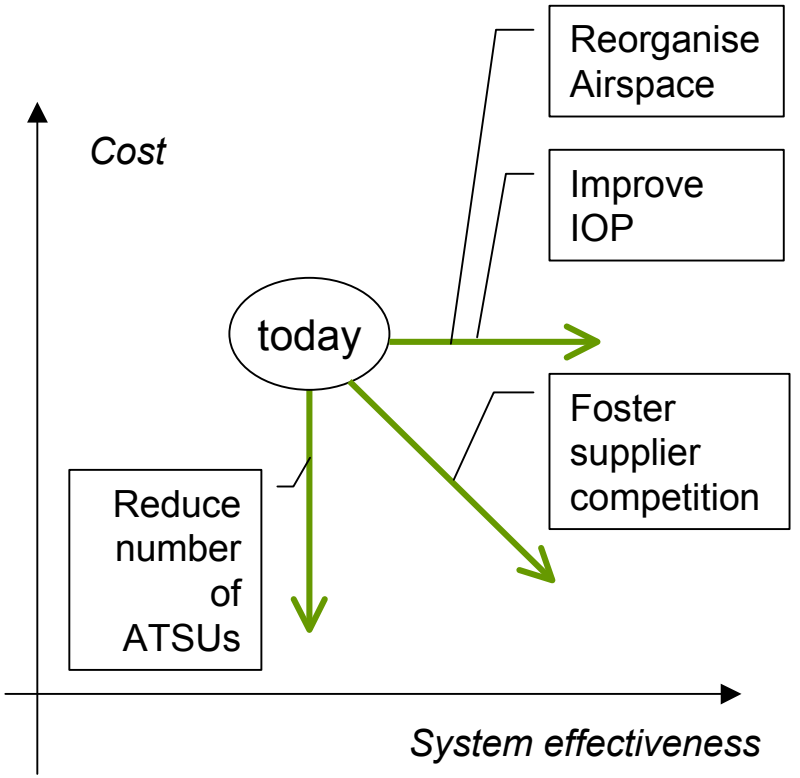
In Search of Cost-effectiveness

Compound metric for trade-off between alternatives:

- **ratio of system effectiveness**
  - Performance / capacity
  - Operational availability
  - Supportability
  - …
- **to life-cycle cost**
  - R&D cost
  - Investment cost
  - Operation and support cost
  - Phase-out cost

Agreement on figures of merit?

$$FOM = \frac{\textit{System-related index}}{\textit{Life-cycle cost}}$$

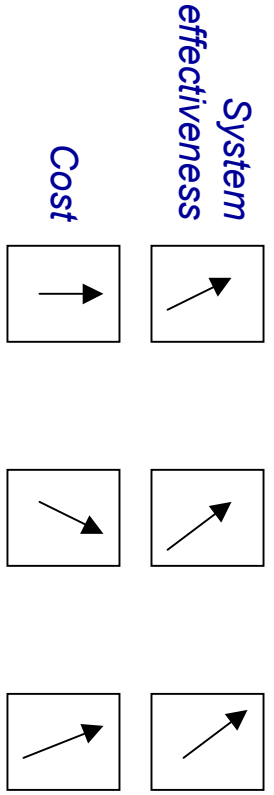


Expected effects of some factors

Investigated Architecture Alternatives

Based on various FM allocation policies in the ATM segment:

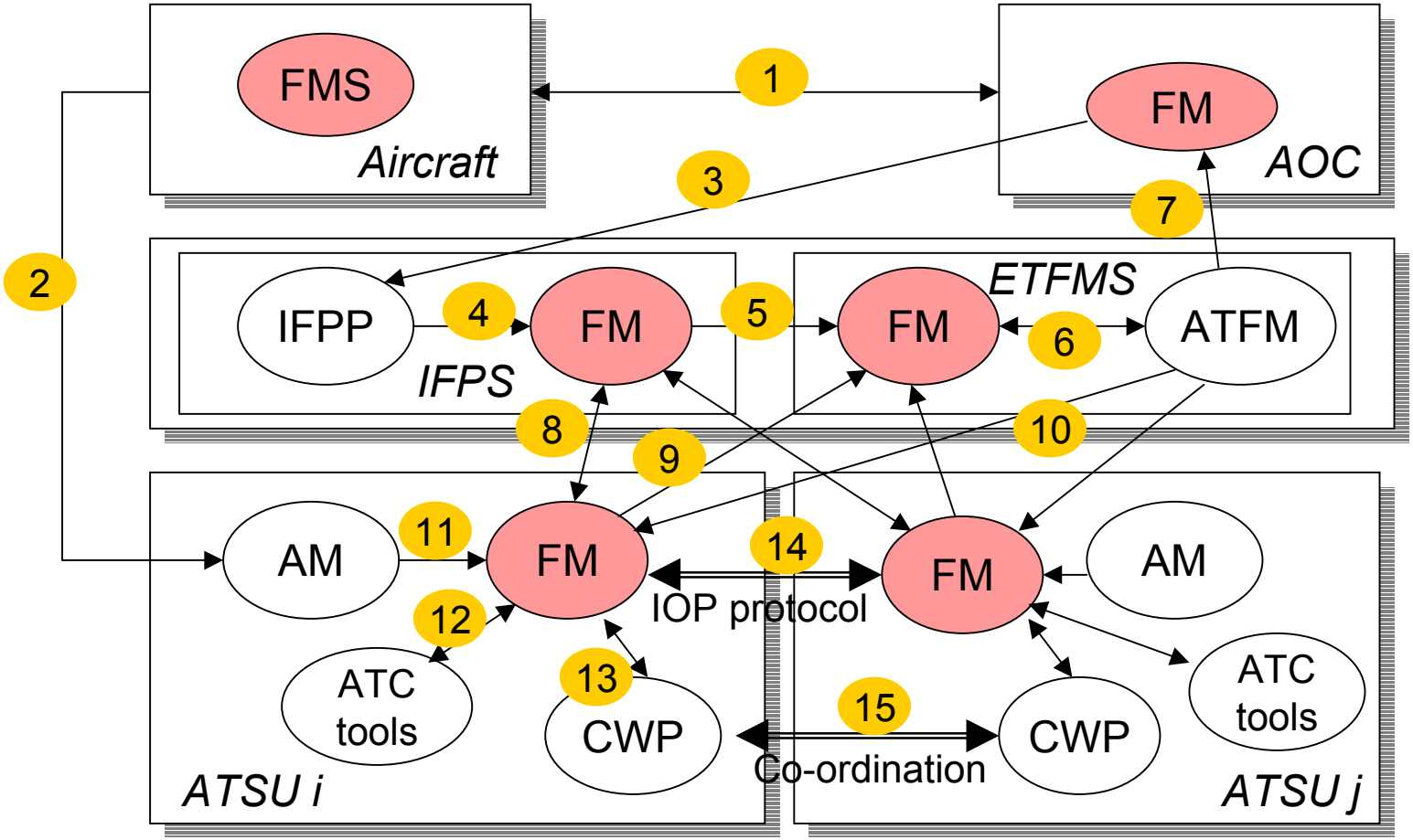
- **The baseline:**
  - Network of enhanced FMs with improved IOP (flight script + 4D trajectory)
  - ETFMS computes ECAC-wide trajectories
- **A centralised approach:**
  - One central FM for en-route ATC and ATFM
- **A compound approach:**
  - Network of enhanced FMs
  - One additional service for FD continuity and IOP management, centralised in a FD warehouse



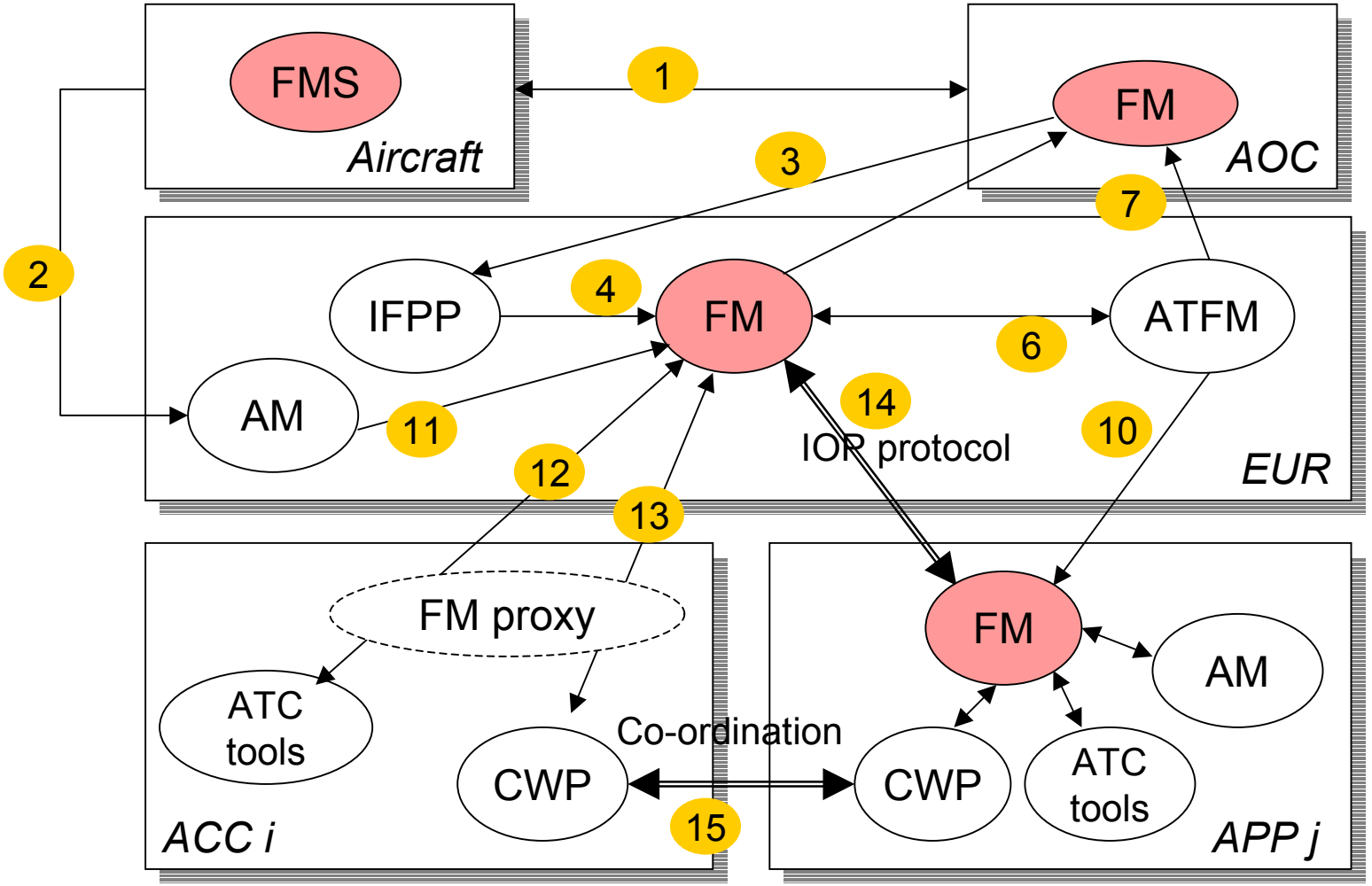
Expected trends

Cost-effectiveness trends do not rank the alternatives. Quantitative assessment is needed.

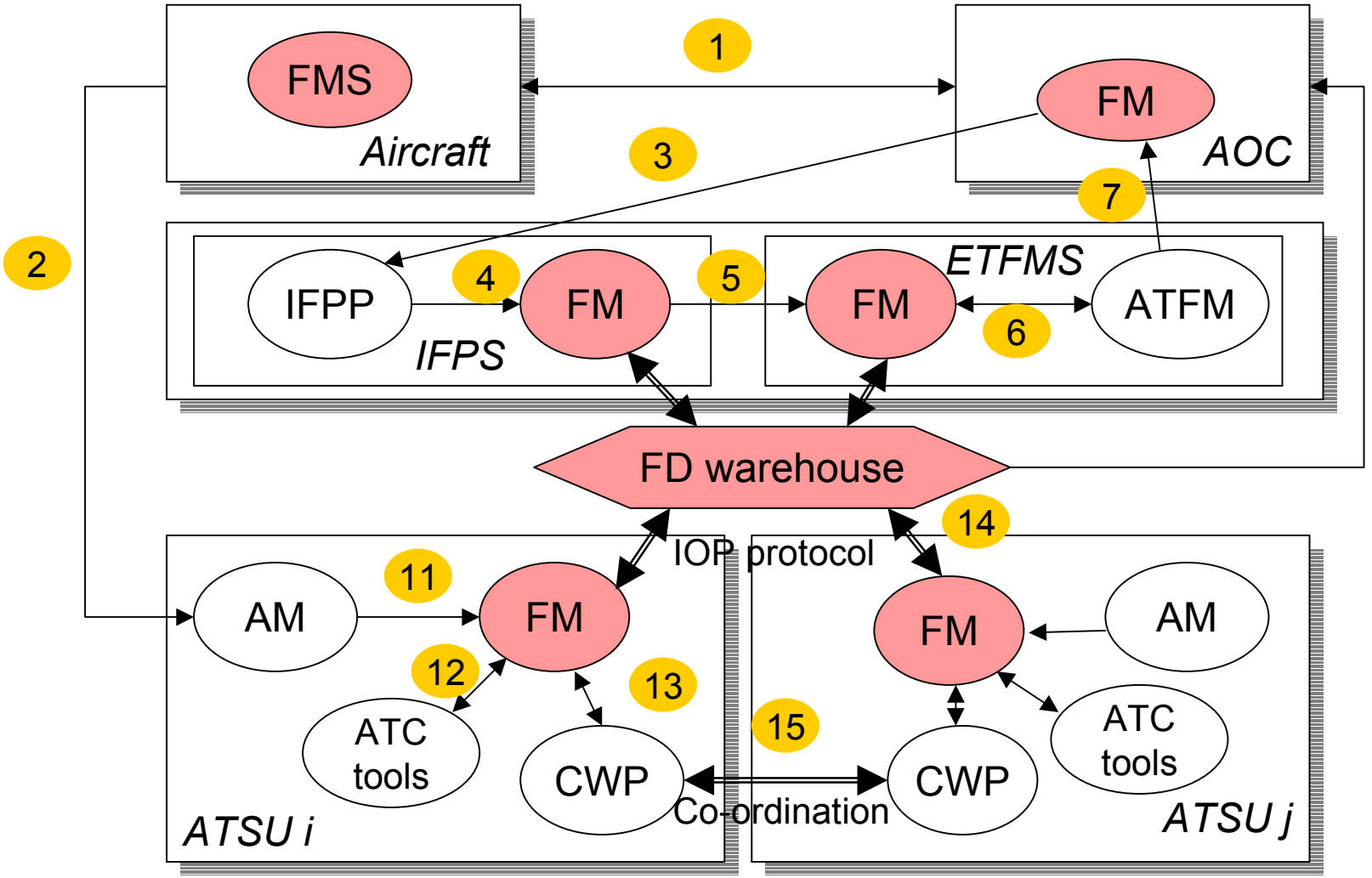
Alternative 1



Alternative 2



Alternative 3



Architecture Evaluation by Stakeholders

- **No unanimity on proposed alternatives nor intermediate solution**
- **Widely-expressed concerns:**
  - A centralised solution introduces security and performance risks and a complex evolution management process
  - Direct ATC-to-ATC data exchange is better for robustness and operational efficiency
  - A distributed solution:
    - Minimises transition risks
    - Facilitates local specificity handling
  - The Flight Manager component is tightly coupled with ATC tools and CWP and difficult to be remotely operated
- **No clear cost-effectiveness advantage for any alternative**

Stakeholders Vision

Operational needs:

- ECAC-wide FD needed by planning functions, mainly for ATFM.
- ATC needs large AoIs for advanced tools and needs to accommodate local specificity
- AOCs are interested in some predicted significant events, not all FD along the flight path
- Consequence: There will still exist distributed and fragmented flight databases with consistency management requirements

Road map for the future

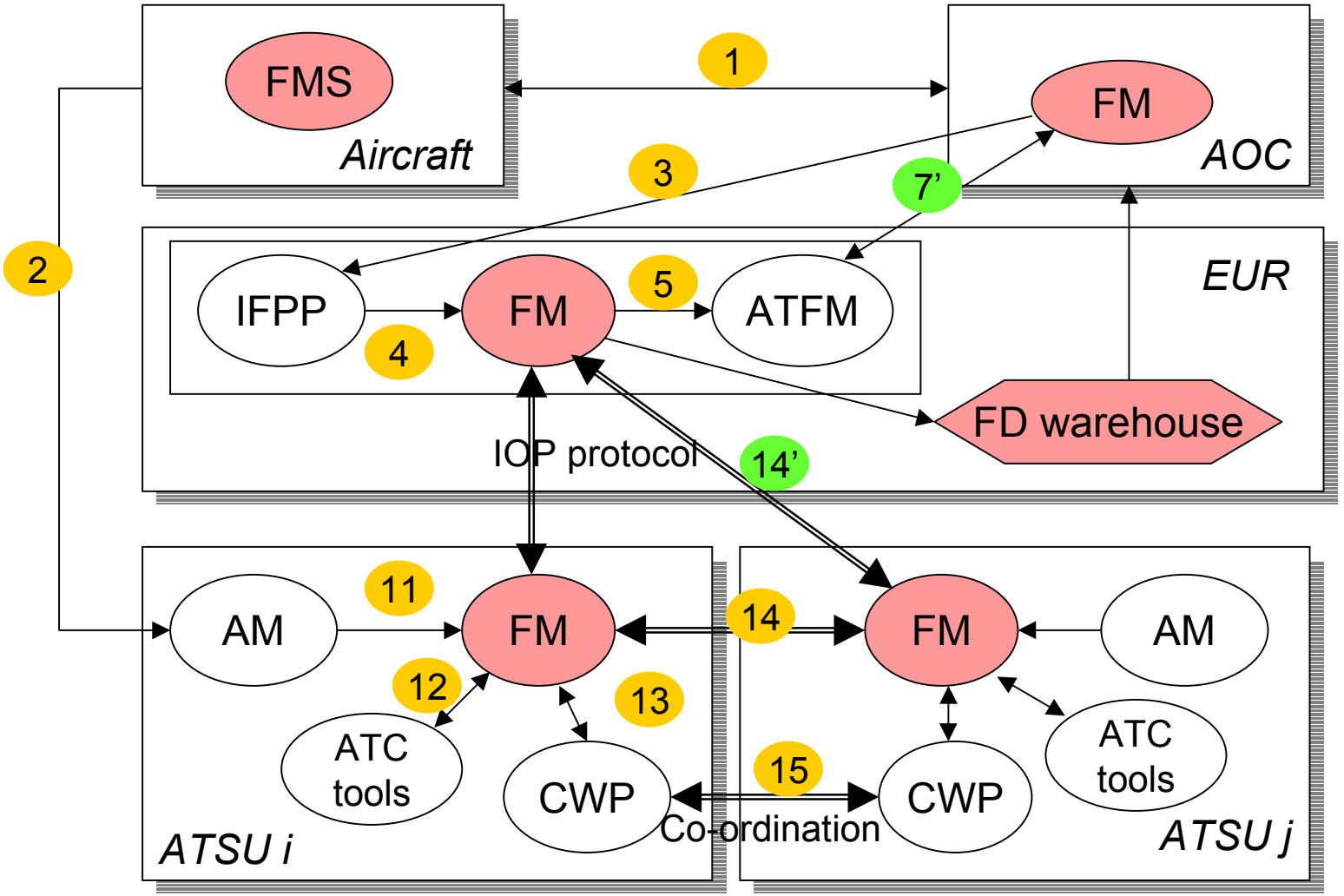
- No big-bang, but an evolutionary approach, starting from existing systems
- Reduction in the number of ACCs (aggregation of small/low traffic AoR)
- Airspace organisation based on traffic patterns
- Principal effort on IOP standard setting

Looking for a Convergence Architecture

2 ATM layers:

- **Central:**
  - ATFM services (enhanced to support CDM with AOC)
  - ECAC-wide FD provision to non-ATM users
  - IOP with local systems for FD consistency
- **Local:**
  - ATC operations
  - peer-to-peer IOP with adjacent ATSUs

Convergence Architecture



European ATM at a Turning Point

- *How does it fit in with future concepts?*
- *Does improved ATM Quality of Service call for drastic institutional changes?*
- *Is it "only" a matter of interoperability standards?*
- *Does it improve cost effectiveness?*