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Training

EPFL Course September 1995: Foundations of ODP

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Abstract

This presentation is based on APM.1513.02 “Building a Better Legacy”.

It was adapted for presentation as part of Module M3 “Distributed Systems” of the course on Communication Networks given at Ecole Polytechnique Federale de Lausanne in September 1995.

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Briefing Note

Distribution:
Supersedes:
Superseded by:

The Foundations of Open Distributed Processing

Using Distributed Object Technology for Effective Systems Integration

The Open Systems Movement needs.....

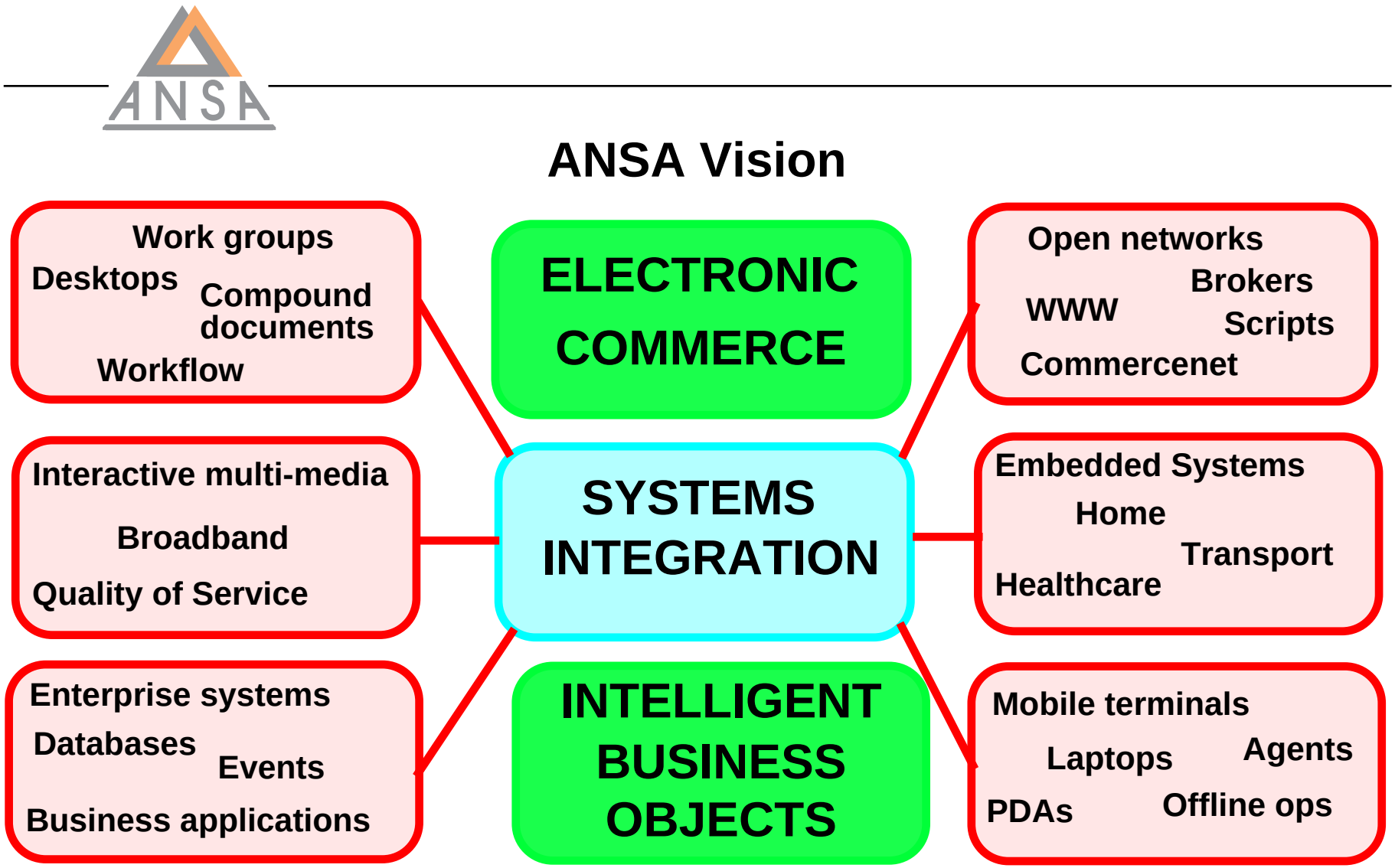
- a credible future open systems vision
  - rationalizing the past isn't enough
- building up from current technologies
  - to maximize return on investment
- intercepting new capabilities
  - to ensure the market grows
- with an order of magnitude reduction in systems integration cost

The ANSA Approach

- **An architecture for Open Systems based on**
  - **trading and federation**
  - **custom infrastructure**
  - **abstract and automate**
  - **modular engineering**
  - **controlled interoperability**
  - **one size does not fit all**
  - **tools replace APIs**
  - **open internal interfaces**
- **developed by the ANSA consortium**
  - **proved in real products and systems**
- **consistent with key industry standards**
- **with a firm grip on the future**

History of the ANSA Process

- **ANSA Consortium**
  - **Founded in 1985**
- **Representative membership**
  - ***computer vendors*** ***telecoms manufacturers and operators***
  - ***systems integrators*** ***end users***
- **Shared core team**
  - **research, scenarios, animations, develop prototypes**
  - **technology transfer** ***secondment, projects, training, consultancy***
  - **influence key standards** ***OSF, OMG, ISO/ITU ODP, TINA***


ANSA Vision
Work groups
Desktops
Compound documents
Workflow
ELECTRONIC COMMERCE
Open networks
Brokers
WWW
Scripts
Commercenet
Interactive multi-media
Broadband
Quality of Service
SYSTEMS INTEGRATION
Embedded Systems
Home
Transport
Healthcare
Enterprise systems
Databases
Events
Business applications
INTELLIGENT BUSINESS OBJECTS
Mobile terminals
Laptops
Agents
PDAs
Offline ops

New Requirements

Interactive Multi-media

Performance

Streams

Real-time scheduling

QoS negotiation

CORBA++

Open Networks

Federated naming

Intelligent broking and trading

Cooperative, autonomous management

Security

MS NETWORK ++

Distributed Information

OLE/COM++

Intelligent information filters and agents

Information servers

Computer assisted business processes

Embedded Systems

Down scaling

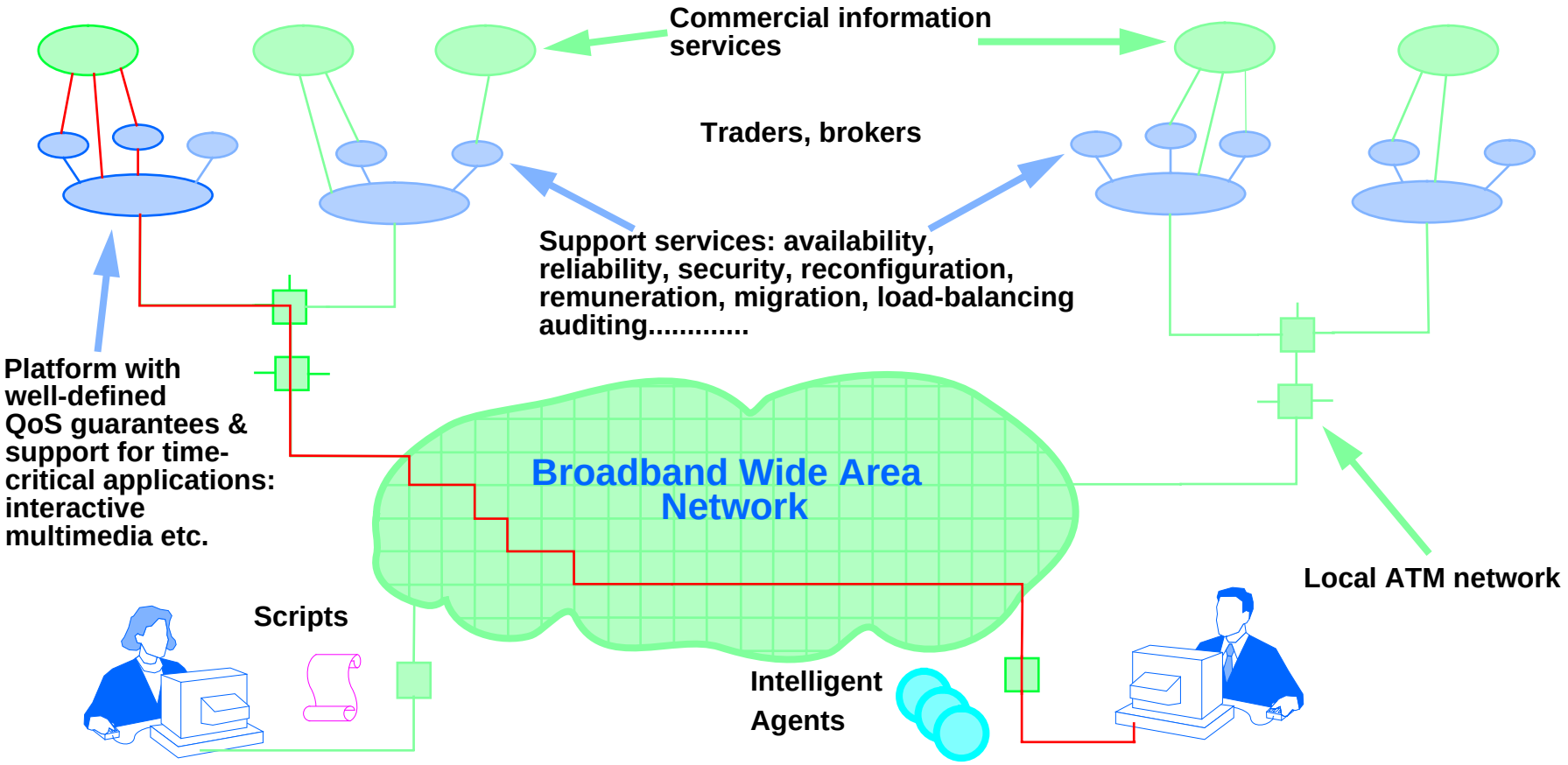
Streams

Asynchronous

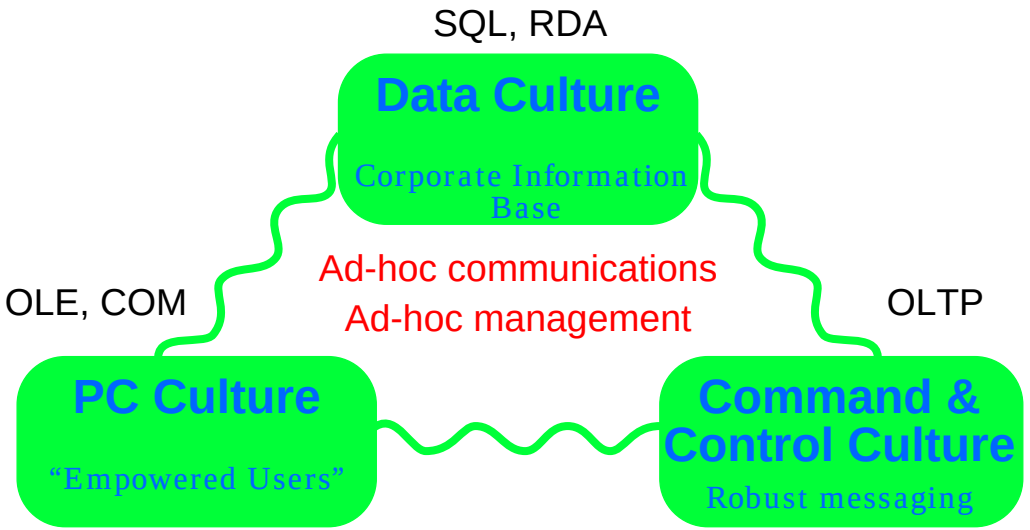
Real-time scheduling

CORBA--

The Technology



Distributed Computing Today



- **Three important and quite separate distributed computing cultures exist**
- **Each has its own means of distribution and application integration**
- **They meet different needs - no single one can absorb the others**

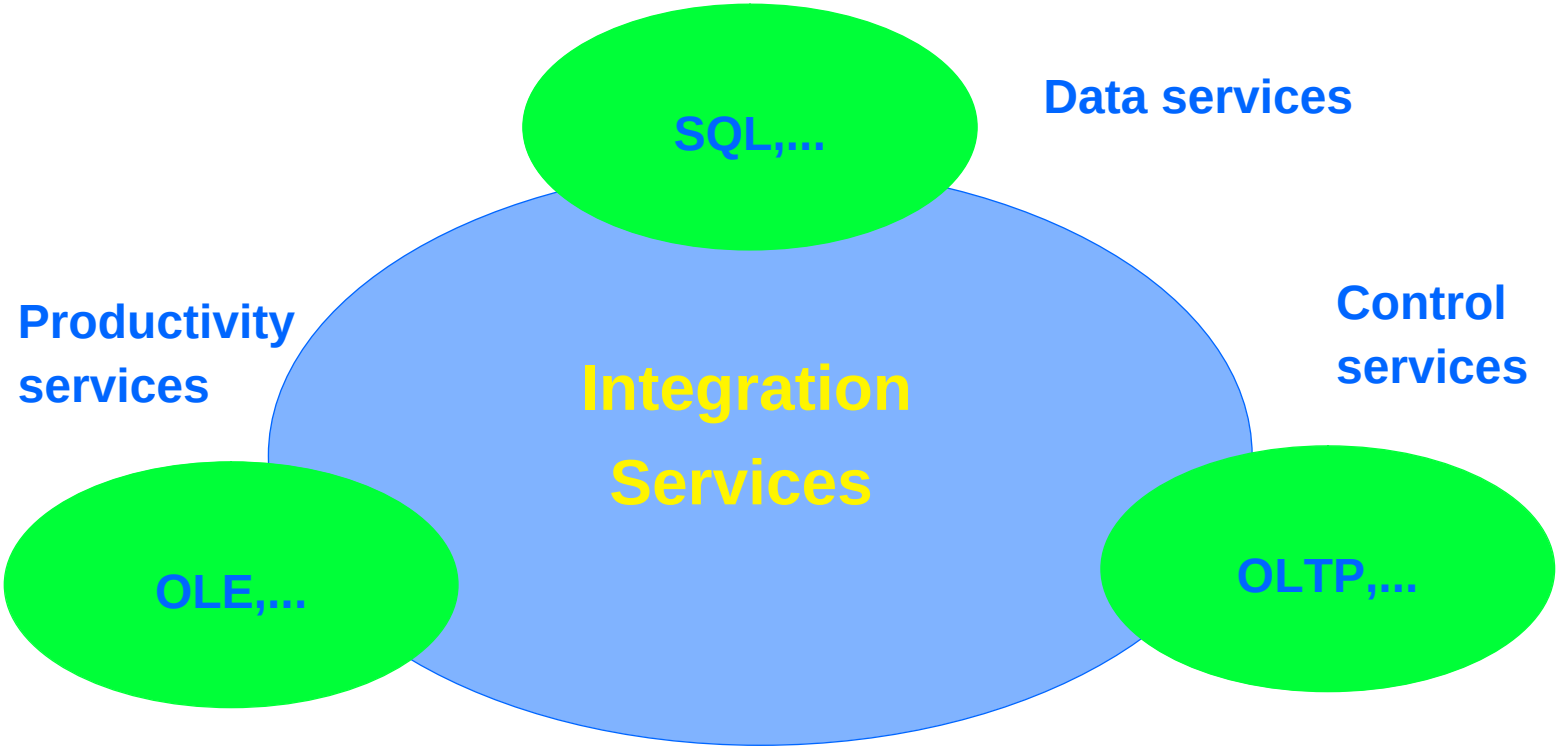
Strengths, Weaknesses

- **Data Culture**
  - +/- Remote data access - mostly proprietary remote login SQL access
  - +/- Federated databases - typically read-only
  - \+ Stored procedures - for high throughput critical business transactions
  - \+ Object repositories - for more flexible structuring, fine grained locking
- **PC Culture**
  - +/- Document sharing (OLE) - scaling issues, passive object model
  - +/- Network Administration - scaling and security issues
  - +/- Workflow - proprietary, not very robust
  - +/- Multi-media - ad hoc, unintegrated
- **Control Culture**
  - \+ On-line transaction processing - reliable message routing and server activation
  - \+ Strong on throughput, failover and security
  - \- Systems programmer oriented API
  - +/- Workflow - preconceived application models

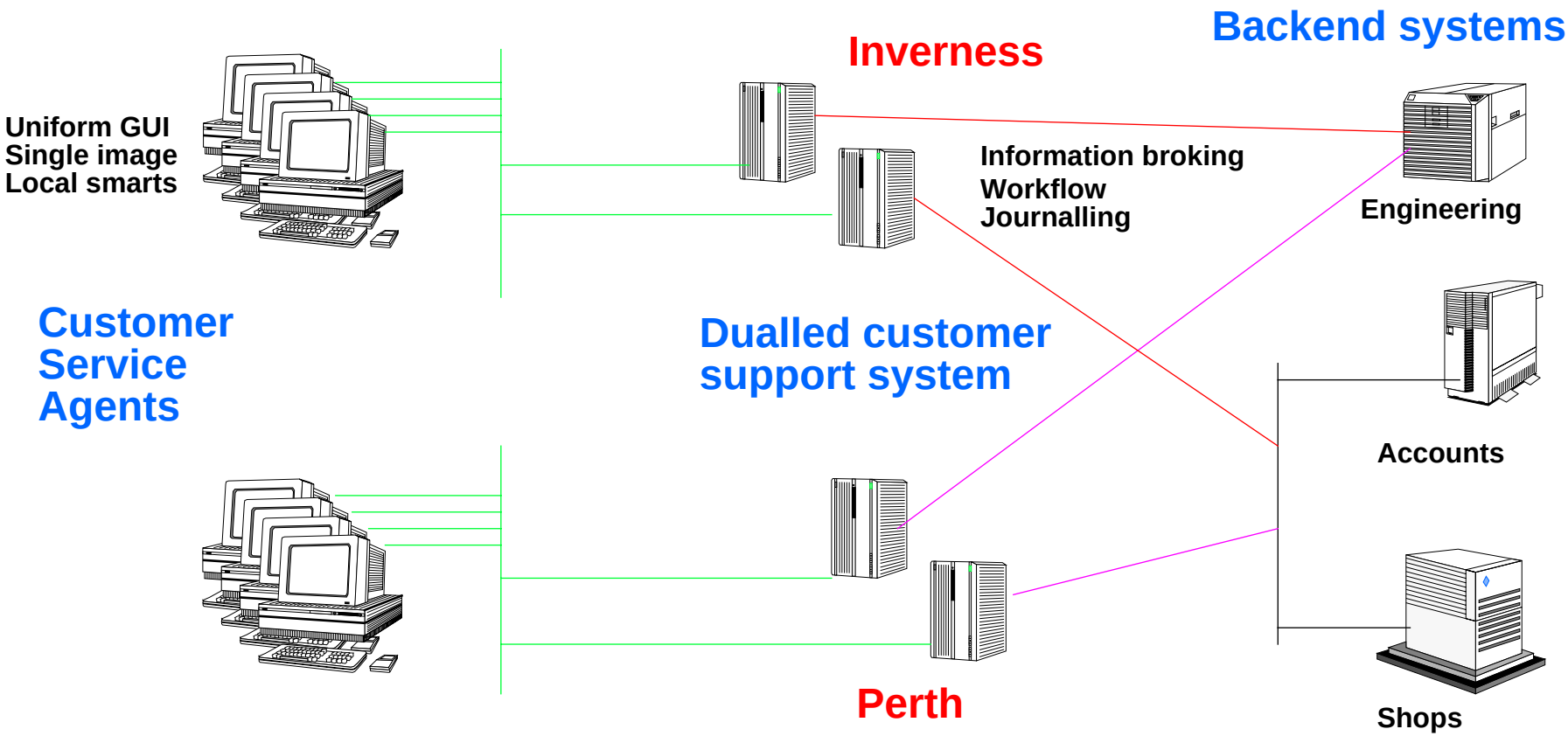
The Systems Integrator's Wish List

- **Integrate products from many vendors - exploit innovation, price/ performance trade-offs**
- **Span application domains - enable information to flow between departments easily**
- **Hide system boundaries - size sould only affect performance, not functionality**
- **Protect enterprise boundaries - preserve autonomy and enable flexibility**
- **Enable inter-organisation computing - controlled federation - doing business doesn't require a merger**
- **Preserve existing investments - enable evolutionary change**
- **Match IT style to Enterprise requirements - make the business drive the system, not the other way round**
- **Allow rapid, low-risk adoption of new technology - be manageable**

Distributed Computing = Integration Services = Interoperability and Management

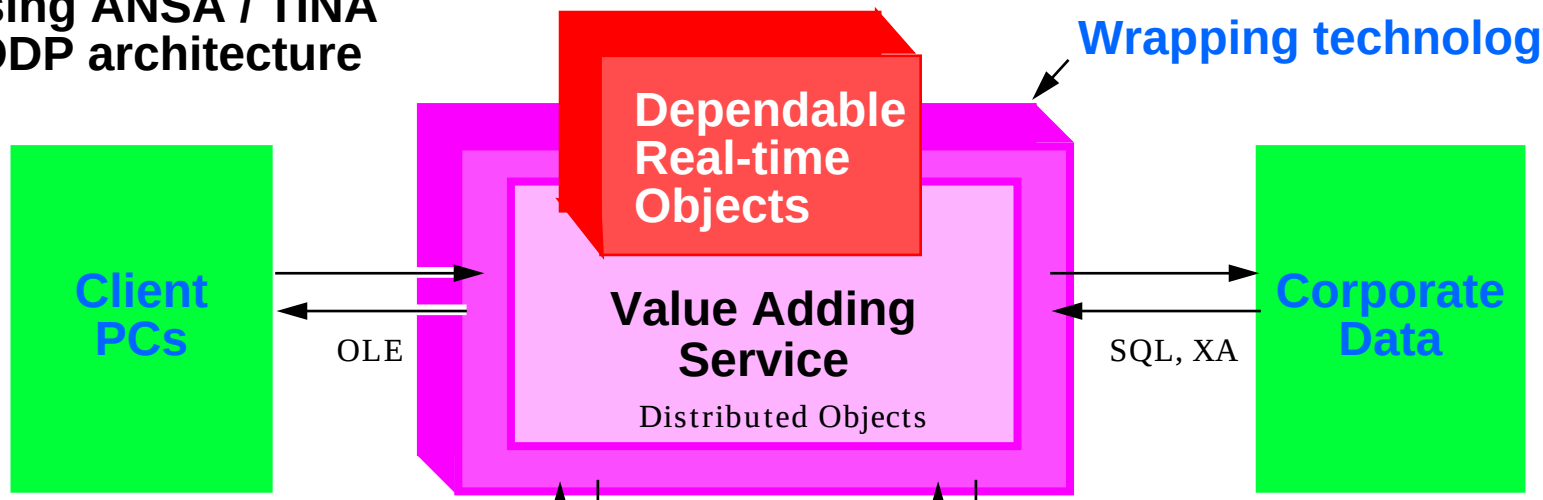


An Example - Scottish HYDRO



A Template for Distributed Object Systems

Using ANSA / TINA / ODP architecture



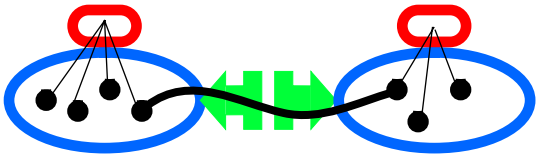
Based on CORBA or COM technology

Applications
NASA ADS
Customer services
Kent Police MOTOS
Radio pager system

Distributed Object Architectures

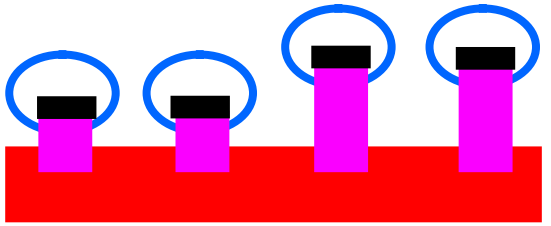
Trading and Federation

Configurable interoperability



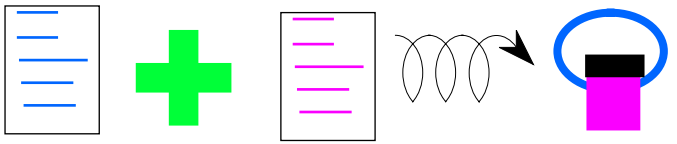
Custom Infrastructure

One size does not fit all



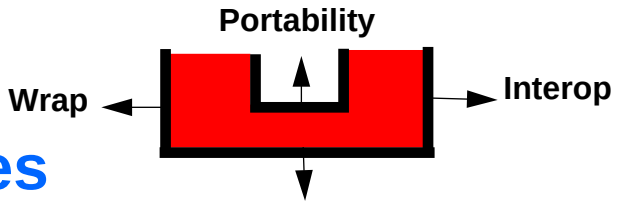
Abstract & Automate

Tools replace APIs

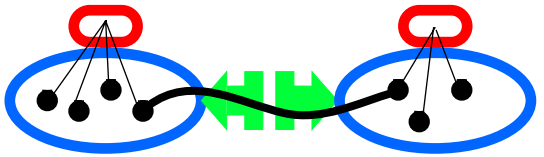


Modular Engineering

Architected internal interfaces



Trading and Federation



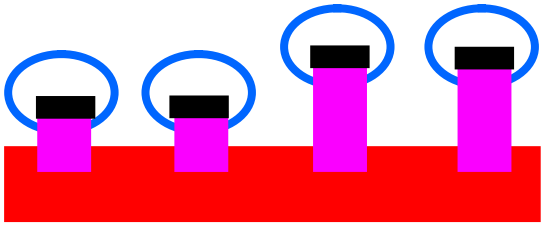
Domains

- **Large systems are made up of autonomous islands interconnected incrementally**
  - **no central authority**
  - **legacy of old technology**
  - **conflicting choices of new technology**
- **Administrative boundaries**
  - **where checks and accounting occur**
- **Technology boundaries**
  - **where protocol conversion and data translation occur**
- **Objects provides services to one another, within domains and between domains**
- **Set up *interceptors* (gateways / bridges) on demand, when trading**

Trading, Binding and Type Safety

- **Trading - discovering an interface that provides a service**
  - ***exporters* make service offers, *importers* make service requests**
  - ***traders* marry imports to exports**
  - **trading allows new services to be introduced and old services upgraded**
- **Binding - establishing resources for interaction to occur**
  - **typically implicit for RPC, explicit for streams, groups and where QoS is controlled**
- **Type safety - match signatures to ensure valid interaction**
  - **“no surprises” rule enables federation**
  - **done when trading, enforced by compiler**

Custom Infrastructure



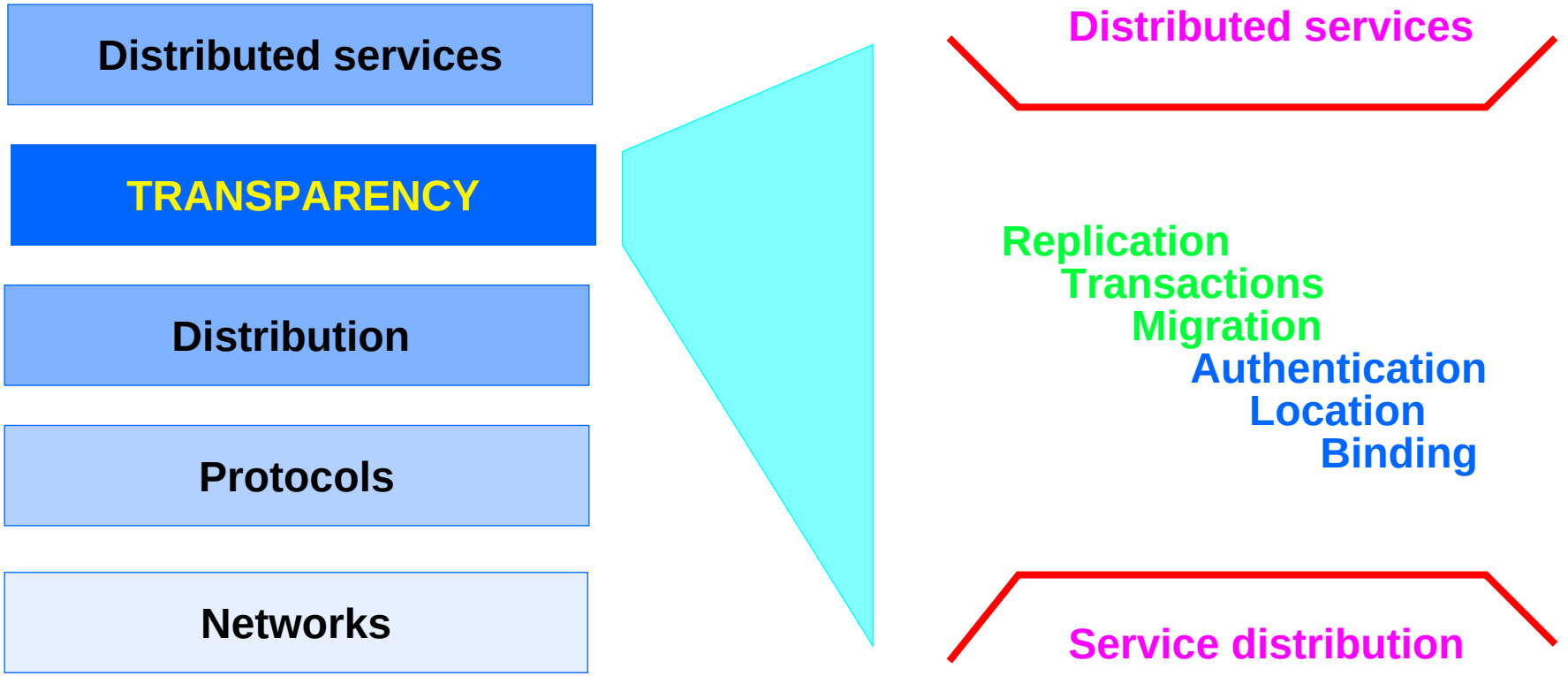
Trade-offs in Distributed Systems

- Distributed systems engineering is all about trade-offs
  - ABSTRACTION versus SPECIALIZATION -the more you hide, the less control you have
  - CONSISTENCY versus AVAILABILITY - availability implies copies, increases risk of inconsistency
  - AUTONOMY versus UNIFORMITY -autonomy gives more freedom but leads to differences which increases complexity
  - SECURITY versus CONVENIENCE - security makes things harder to do
- Therefore we need a kit of parts and an open framework into which they slot
- Moreover the framework must accomodate coexistance of alternative parts for the same job

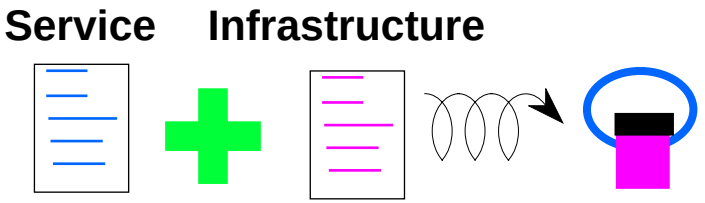
Selective Transparency

- **Transparency is about hiding irrelevant complexity**
  - **Location** — don't need to know where it is to use it
  - **Access** — don't need to know how it works to use it
  - **Migration** — it can move while you're using it to balance loads or reduce latency
  - **Replication** — there may be copies for reliability and/or availability
  - **Persistence** — it only gets resources when it needs them
  - **Partial Failure** — it always gets to a consistent state
  - **Federation** — you don't have to have the same administrator to use it
- **The transparency layer supports the functionality of the basic service distribution layer, and adds additional guarantees**
  - same API for issuing requests
  - extra management functions for controlling transparency

Engineering Framework



Abstract and Automate

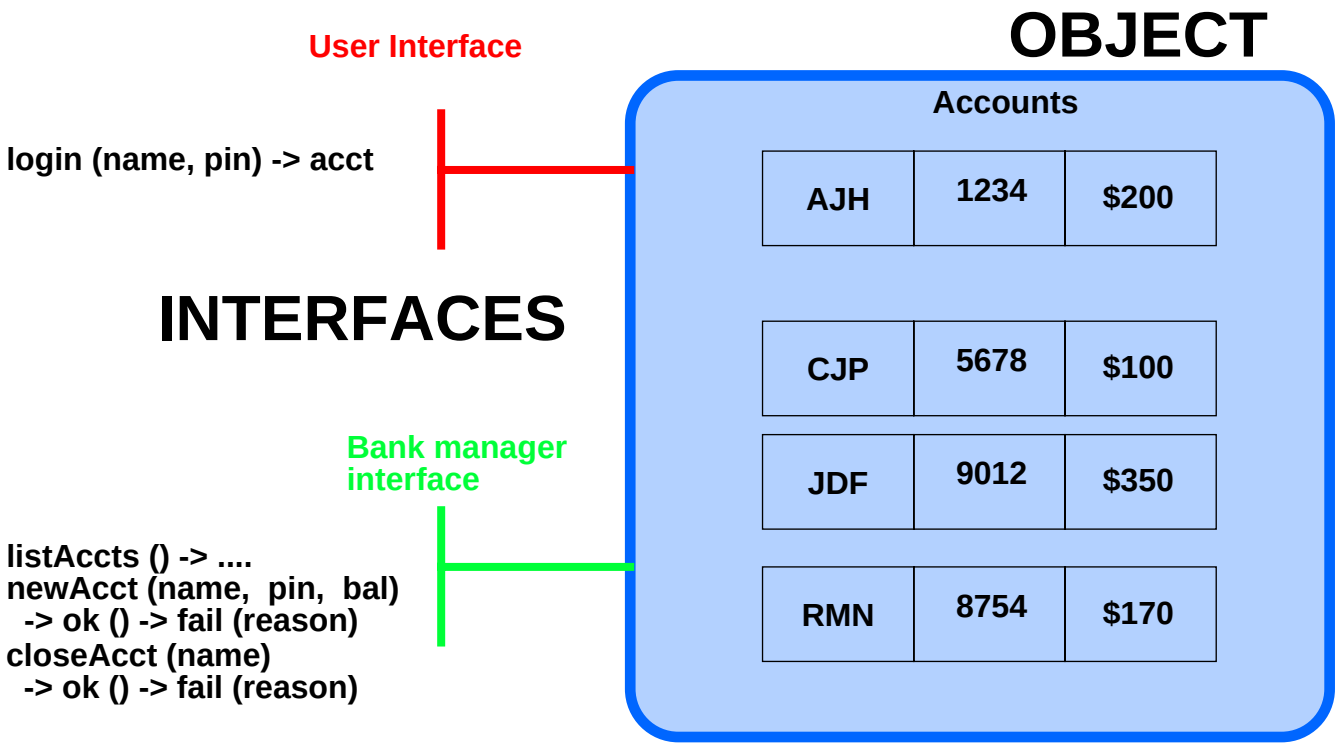


Distributed Programming is Different

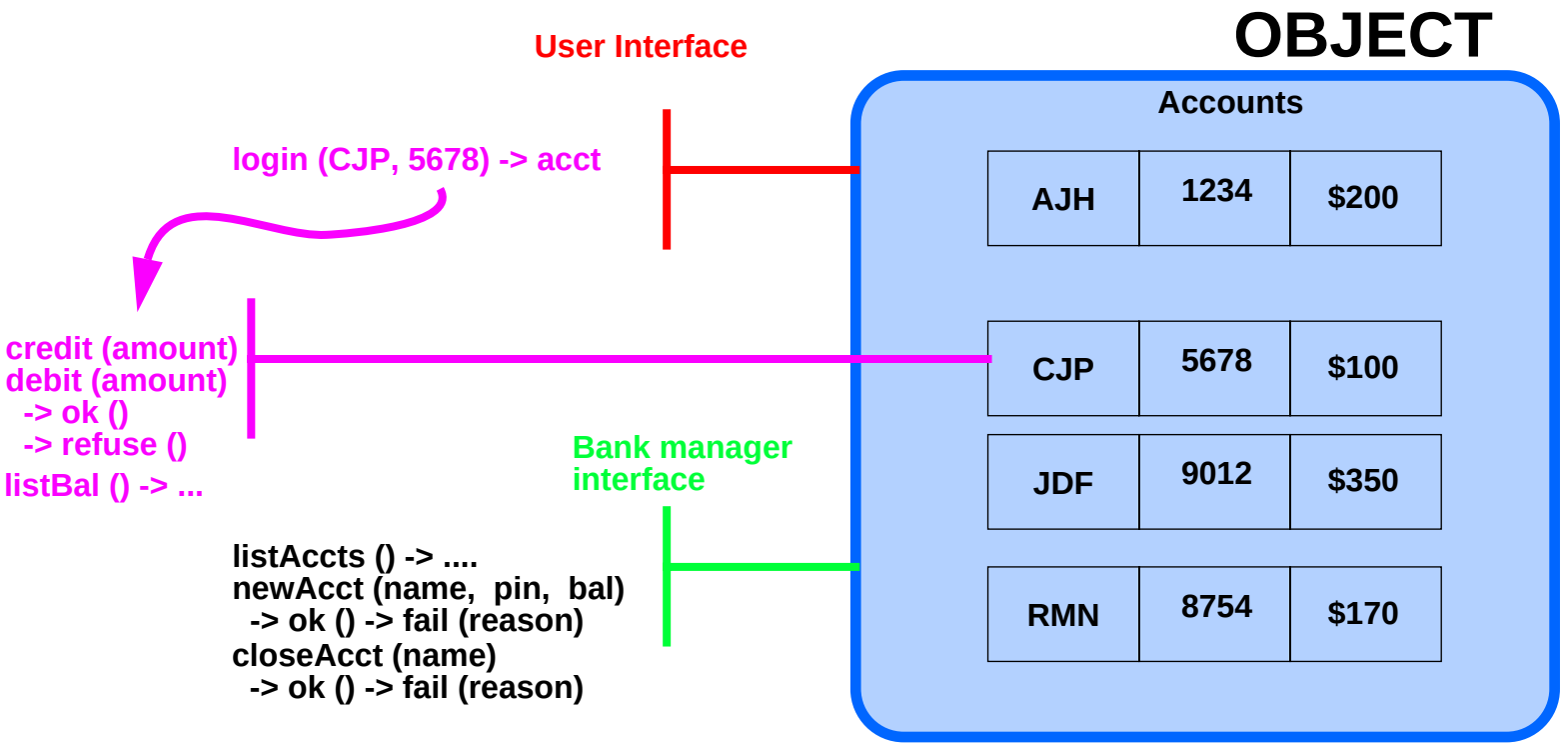
TRADITIONAL	REVERSED
Local	Remote
Sequential	Concurrent
Single Environment	Diverse Environment
Fixed Location	Mobile
Single Copy	Multiple Copies
Synchronous	Asynchronous
Direct	Indirect
Shared	Separate
Global	Context Relative
Complete failures	Partial Failures
Early Binding	Late Binding

- Trying to wedge this into a traditional view won't work

Distributed Object Model (1)



Distributed Object Model (2)



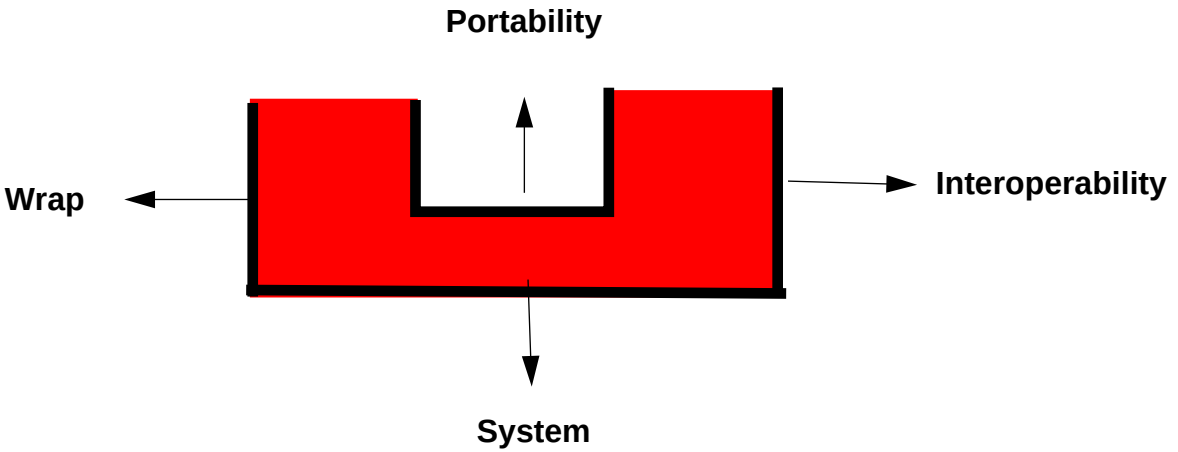
Why Do APIs Grow So Large?

- **Rich set of concepts needed for distributed programming**
  - threads
  - requests
  - replication
  - atomicity
  - .....
- **Optimized engineering for common cases**
  - e.g. forked call -> asynchronous call to save a local thread
- **Special engineering for special cases**
  - e.g. spawned atomic call -> start new top level transaction
- **Combinatorial explosion in functions overwhelms the programmer**

Let Compilers and Tools Take The Strain

- **Exploit abstraction, program in application oriented concepts**
  - **most aspects of OO really help, some hinder**
- **Simple (pre-processor) extensions go a long way**
  - **especially if leveraging an OO language**
- **orthogonality - e.g. “dot” and “bar” *vs*. threads and RPC API**
  - **languages minimize complexity without losing scope for optimization**
- **declarative - state requirements and policies not mechanisms**
  - **point already proven by IDLs and stub generators**
  - **decouple applications from engineering - ANSA PREPC experience**
- **strong type checking for safety and confidence**

Modular Engineering



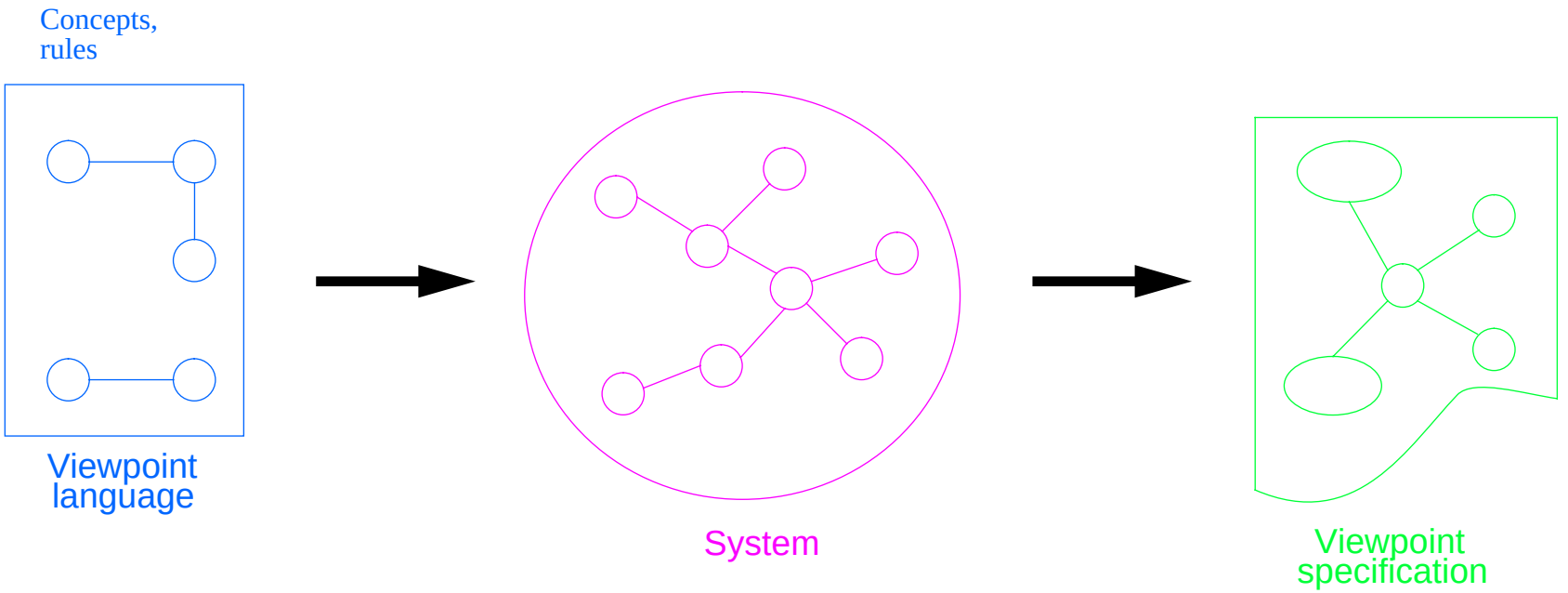
The Rest of the Picture

- So far we have covered technology issues
- The complete ANSA/ODP Architecture has five viewpoints of which computation and engineering are only two
  - the other viewpoints bring in business models and requirements
  - the other viewpoints emphasize the need for tools and online system metadata
- The broader framework has been carried into the ISO/ITU Reference Model for Open Distributed Processing

Languages and Viewpoints (1)

- *ODP Framework* consists of five *viewpoint languages* and a set of *infrastructure functions*
- Each viewpoint language enables specification of an ODP system or component
- Languages are structured so that *consistency checking* between alternative viewpoint specifications is possible
- The chosen set is *necessary* and *sufficient* for needs of ODP
  - clear separation of concerns (requirements, design, implementation)
  - maximum scope for federation, transparency and modularity
- Each language consists of *concepts* (vocabulary) and *rules* (grammar)

Languages and Viewpoints (2)



- **Mathematical basis in *projection* of a set of concepts and abstraction/ specialisation relations over a semantic net.**

Viewpoints

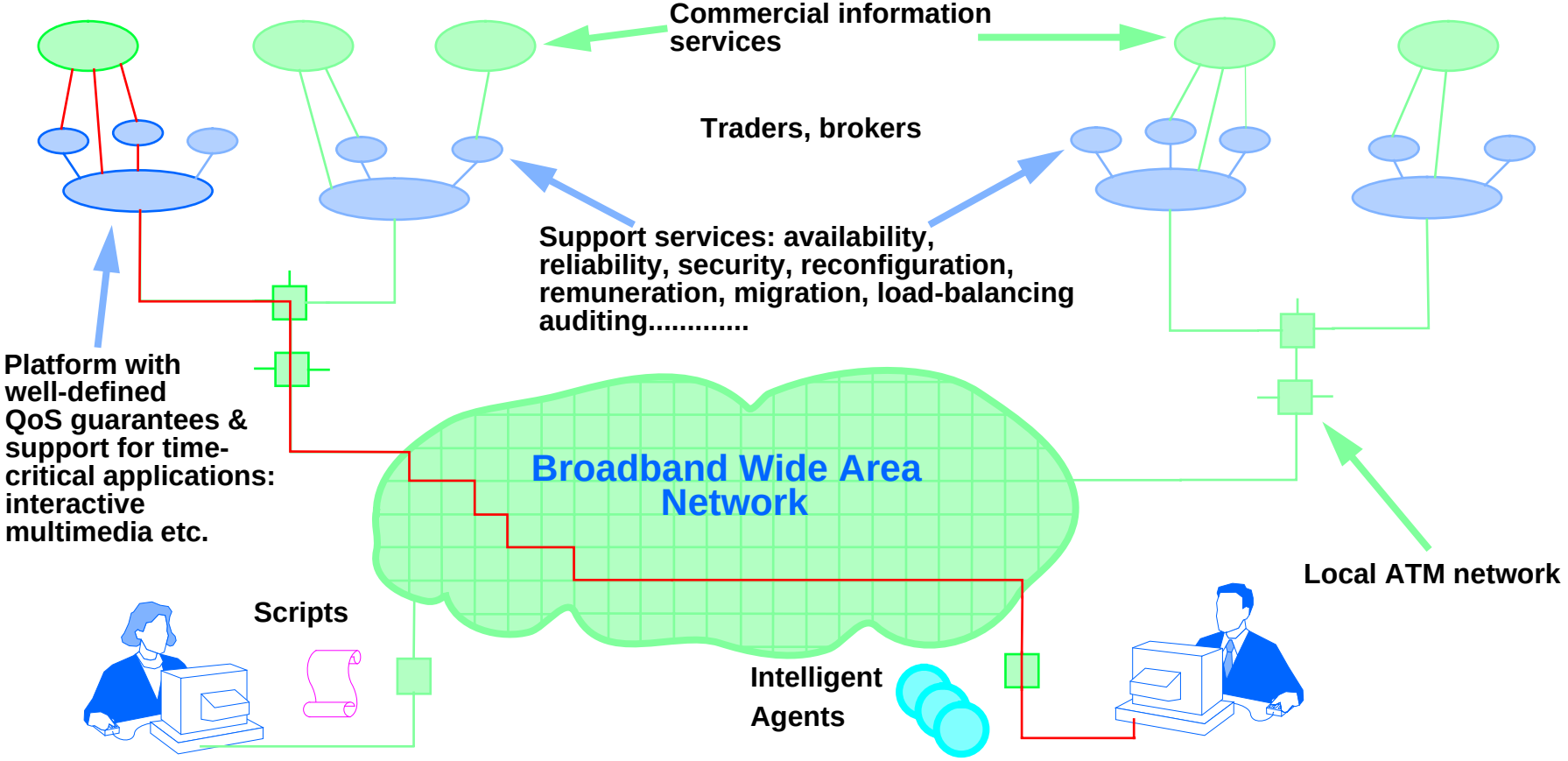
- **Enterprise - purpose, scope and policies for a system**
  - business process models, policy models
- **Information - kinds on information handled by the system and constraints on the use and interpretation of that information**
  - data models, data flows, data consistency constraints
- **Computational - functional decomposition into objects suitable for distribution**
  - functional design
- **Engineering - the infrastructure required to support distribution**
  - implementation block diagram
- **Technology - the choice of technology to support distributio**
- **Don’t equate viewpoints to design process refinement steps!**

The Status of ANSA: Implementing ODP

- All except security has been built for the ANSAware prototype
- ANSAware anticipated DCE RPC, IDL and threads by 2 years
- ANSAware anticipated CORBA, object life cycle and UNO by 2 years
- ANSAware has fed into products by HP, ICL, BT, Bellcore, GPT, AEG
- ANSAware ‘93 included DCE RPC and threads coexisting with previous home-grown solutions
- ANSAware ‘94 development majored on real-time and streams
- ANSAware ‘95 development is majoring on WWW, interceptors and repository management

Summary

The Vision


Commercial information services
Traders, brokers
Support services: availability, reliability, security, reconfiguration, remuneration, migration, load-balancing auditing.....
Platform with well-defined QoS guarantees & support for time-critical applications: interactive multimedia etc.
Broadband Wide Area Network
Local ATM network
Scripts
Intelligent Agents

How ANSA is Helping to Spread ODP

- **ANSA Architecture for Open Systems**
  - trading and federation
  - selective transparency
  - abstract and automate
  - modular engineering
  - controlled interoperability
  - one size does not fit all
  - tools replace APIs
  - architected internal interfaces
- **Developed by the ANSA Consortium**
  - proved in real products and systems
  - consistent with key industry standards
  - with a firm grip on the future
- **ASNA Services**
  - ANSA Research, ANSA “Object Laboratory”
  - ANSA Consulting, ANSA Training, ANSAware