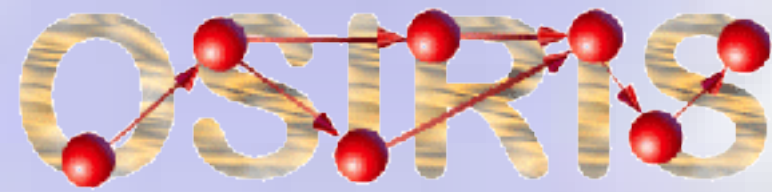# Peer-to-Peer Process Execution with OSIRIS

**Christoph Schuler*, Roger Weber*, Heiko Schuldt#, Hans-J. Schek***

1st International Conference on Service Oriented Computing, December 2003, Trento, Italy

*) Database Research Group, Swiss Federal Instit. of Technology ETH, Zurich, Switzerland
**#) University for Heath Informatics and Technology UMIT, Innsbruck, Austria**

- **Internet-scale Web Service Composition**

  – Composing Web services

  – Services everywhere

- **OSIRIS Architecture**

  – Peer-to-Peer Process Execution

  – Metadata Replication

- **Performance Evaluation**

  – Scalability Characteristics

- **Conclusion and Outlook**

Web Service Composistion
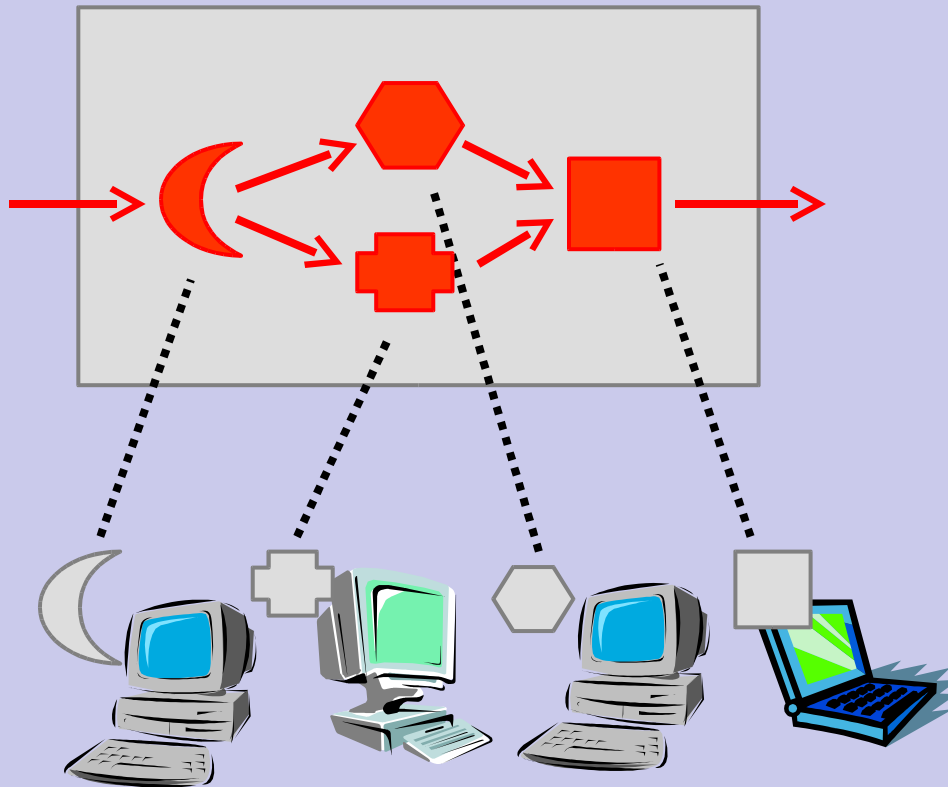
- "Mega programming" or "Programming in the large" combine existing service to value added services
  - Recursively reusing services

- Processes allows for visual programming .

- What infrastructure to define and execute processes?
  - BPEL4WS Modeling Tool
  - State-of-the-art process management system

Scale to internet size
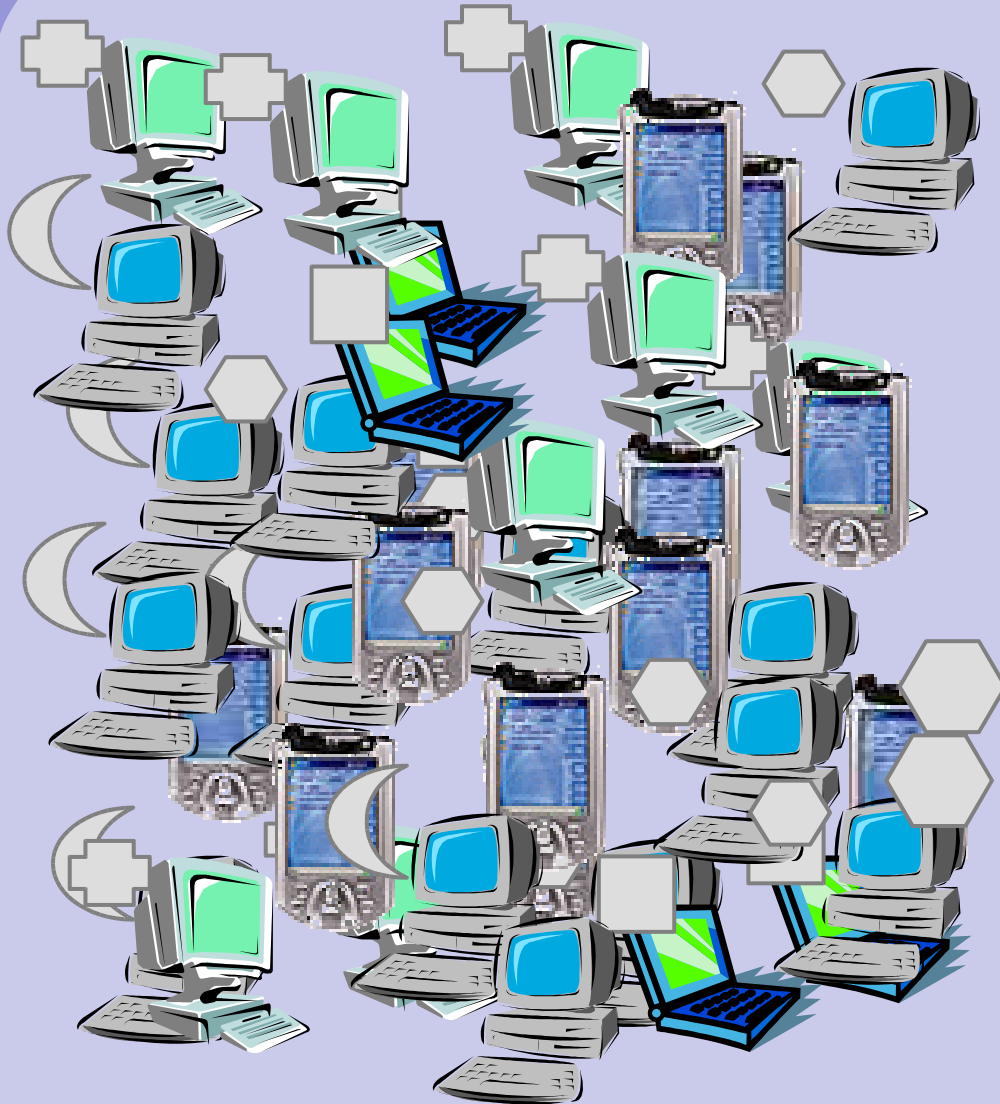
- Service composition on **Internet-scale**
- **Number of services** increases dramatically
  - **On-Demand Computing**
  - **GRID Initiatives**
- **Continues fluctuations** on system configuration

- **What system architecture can manage this situation ?**
  - **Classical process management system?**
  - **In 10 years?**
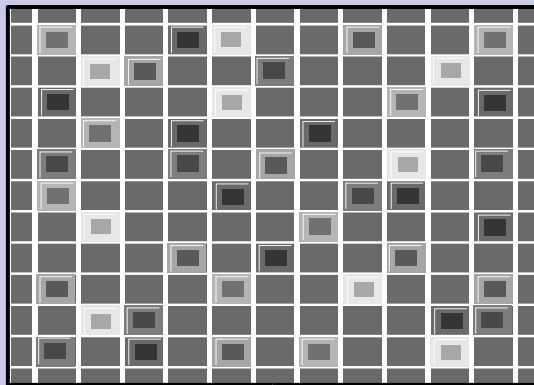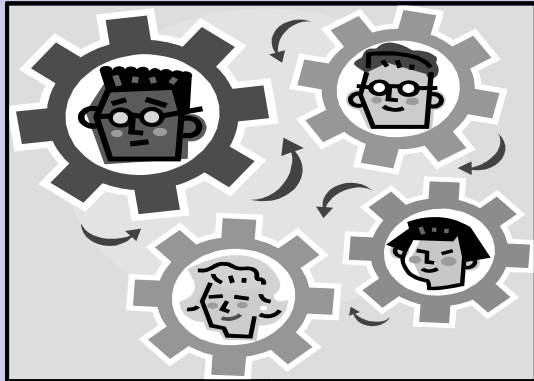
- **Process Management**
  - Programming in the Large
  - Visual Programming
  - Reuse of existing services
  - Composite Services

- **GRID Computing**
  - Self adaptaion
  - On demand computing
  - Resource Management
  - Publish-and-Subscribe
    - Load Balancing
    - Service Bus
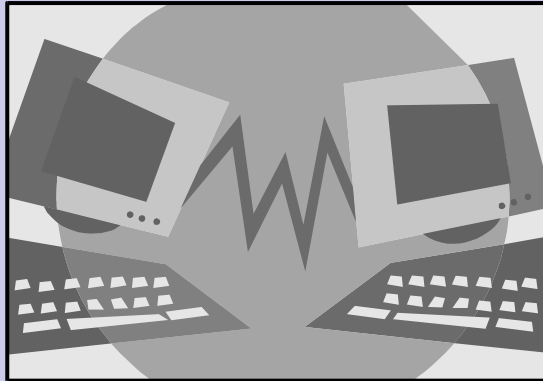
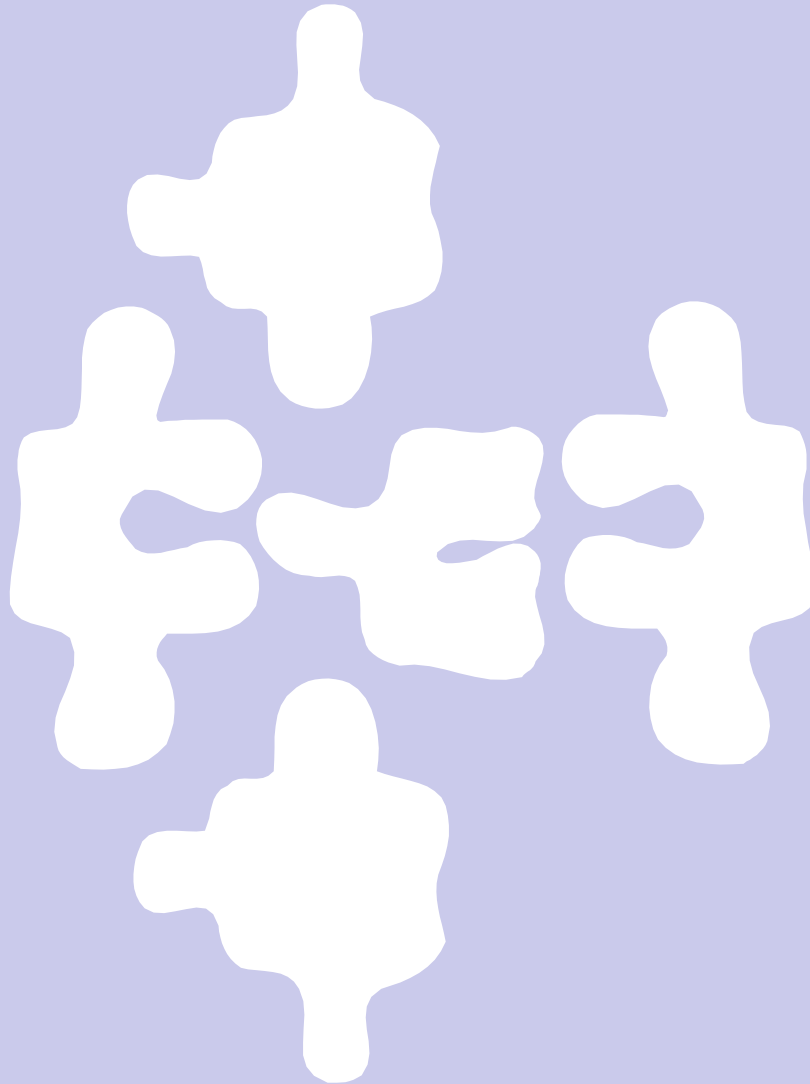- **Peer-to-Peer**
  - Direct communication
  - Scalability
  - Spans large scale communities

- **Database Technology**
  - Atomicity
  - Consistency
 - Isolation
  - Durability

OSIRIS Idea

- **Processes** to combine services

- **Peer-to-peer** execution of processes

- **Support for dynamic system configuration** (GRID)

- **Resource and Metadata Management** (GRID)

- **Providing Execution Guarantees** as known from databases

→ **OSIRIS** = **O**pen **S**ervice **I**nfrastructure for **R**eliable and **I**ntegrated Process **S**upport

OSIRIS Architecture

Load Repository

Subscription List

		C	E	F
		P	R	

Process Specs

Services & Data

OSIRIS

OSIRIS

Services & Data

OSIRIS Layer

Services & Data

OSIRIS Layer

Services & Data
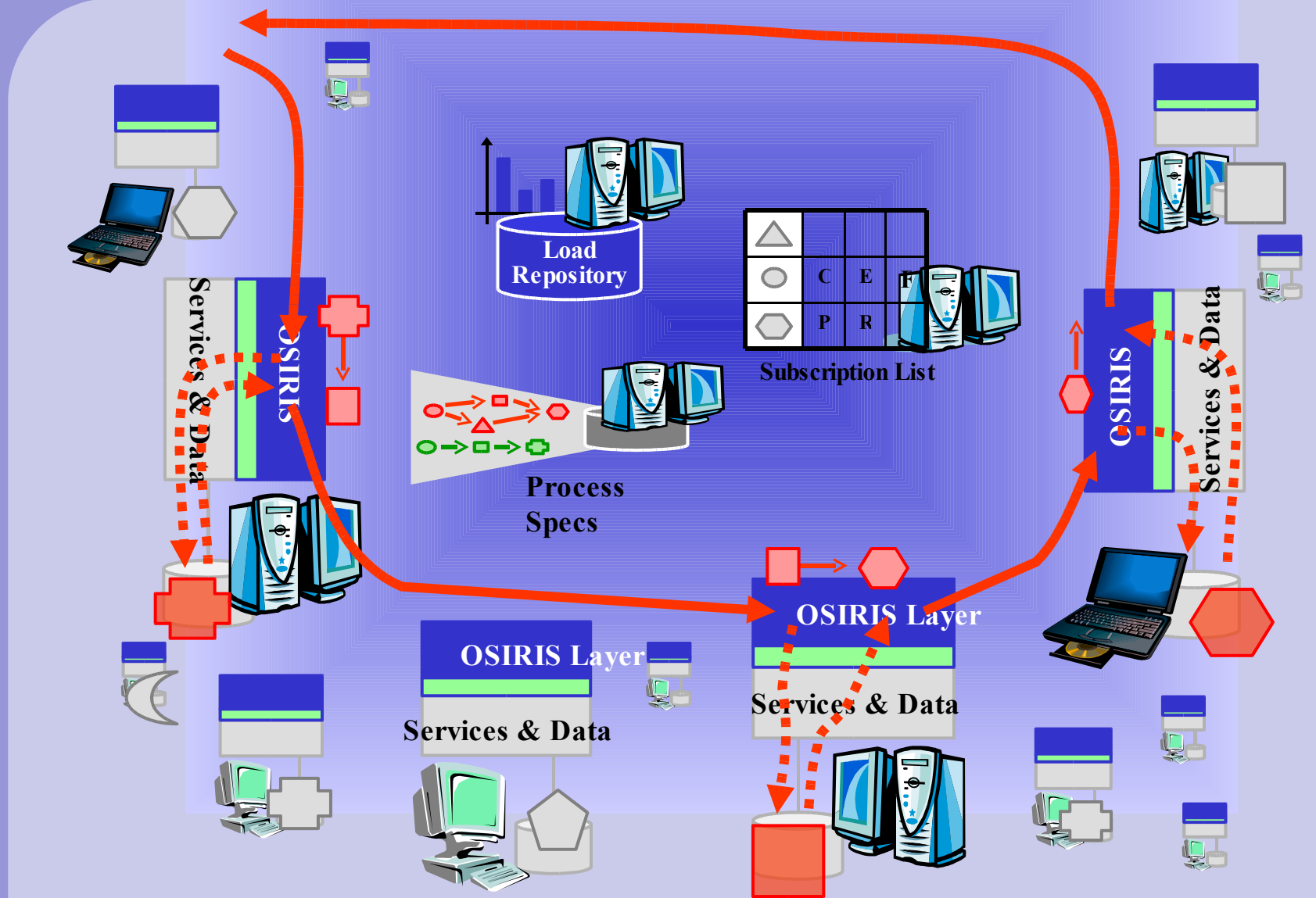
Late Service Binding - Routing

OSIRIS Open Service Infrastructure for Reliable and Integrated process Support
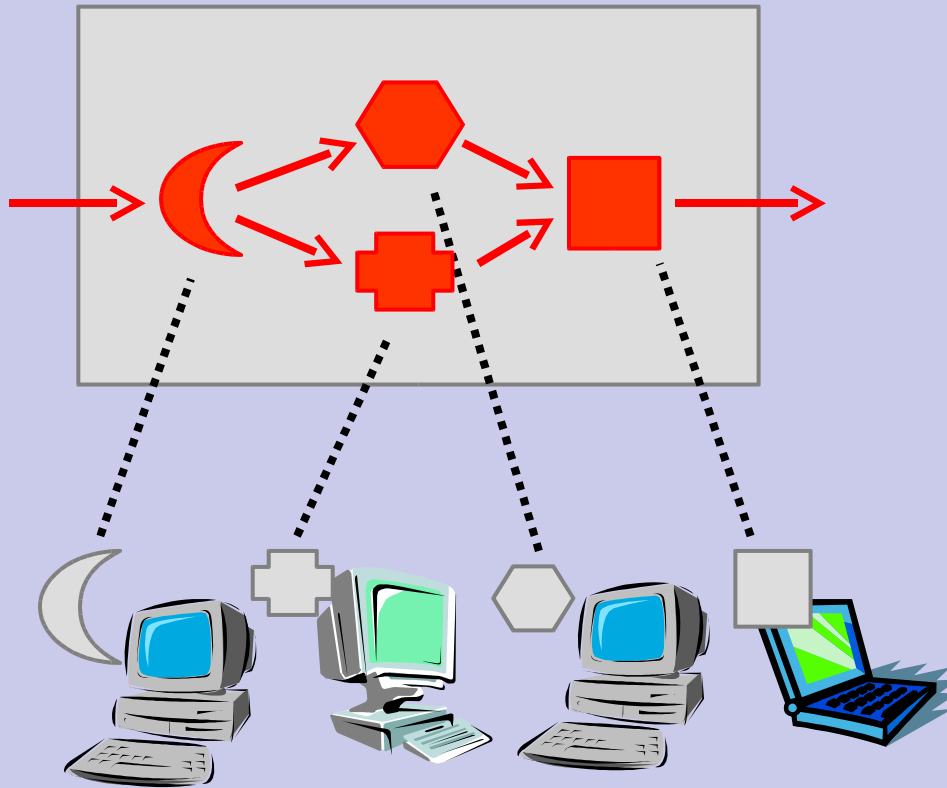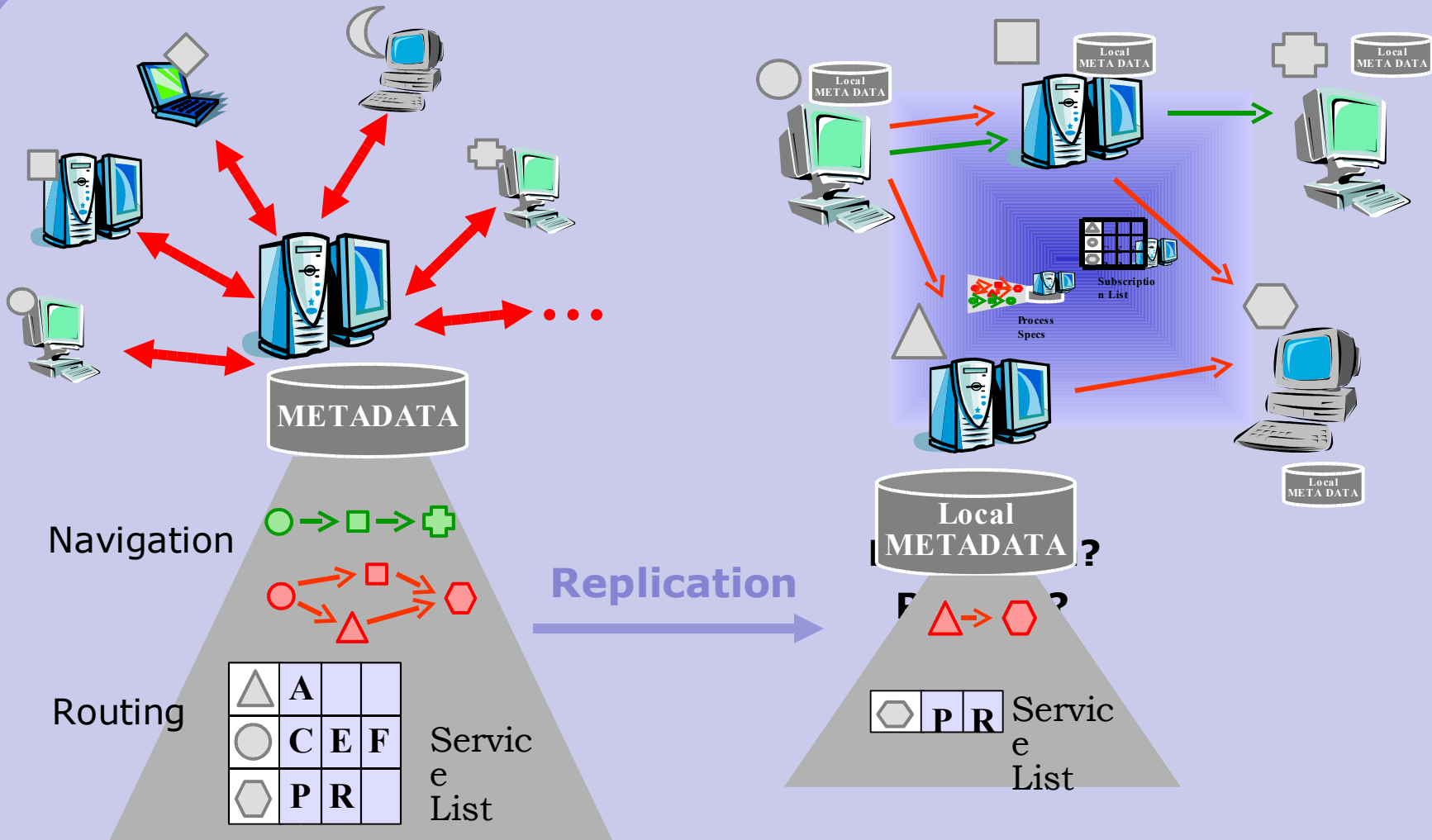
- **More than one** provider of a service type.

- **Process definition**
  - No concrete binding
  - Service Type
  - Semantic Specification

- **Publish-to-ONE** routes process instance to subsequent step
  → Cluster Subscriber
  → "Service Bus"

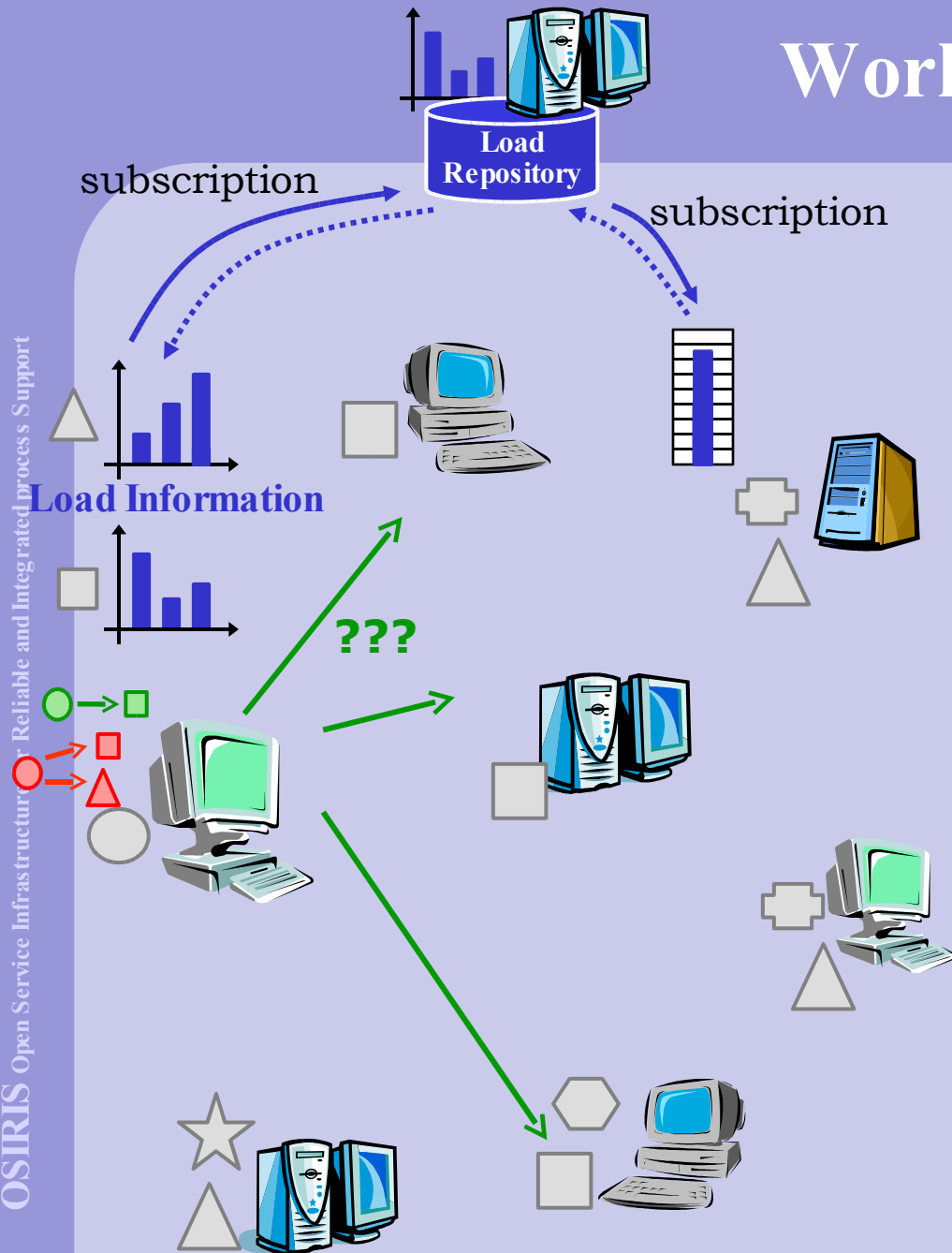- **OSIRIS** implements Publish-to-ONE without
  - Central hub
  - Broadcast

Metadata Replication

Replication

Navigation

Routing

Local METADATA

Service List

Replication Example: Process Data
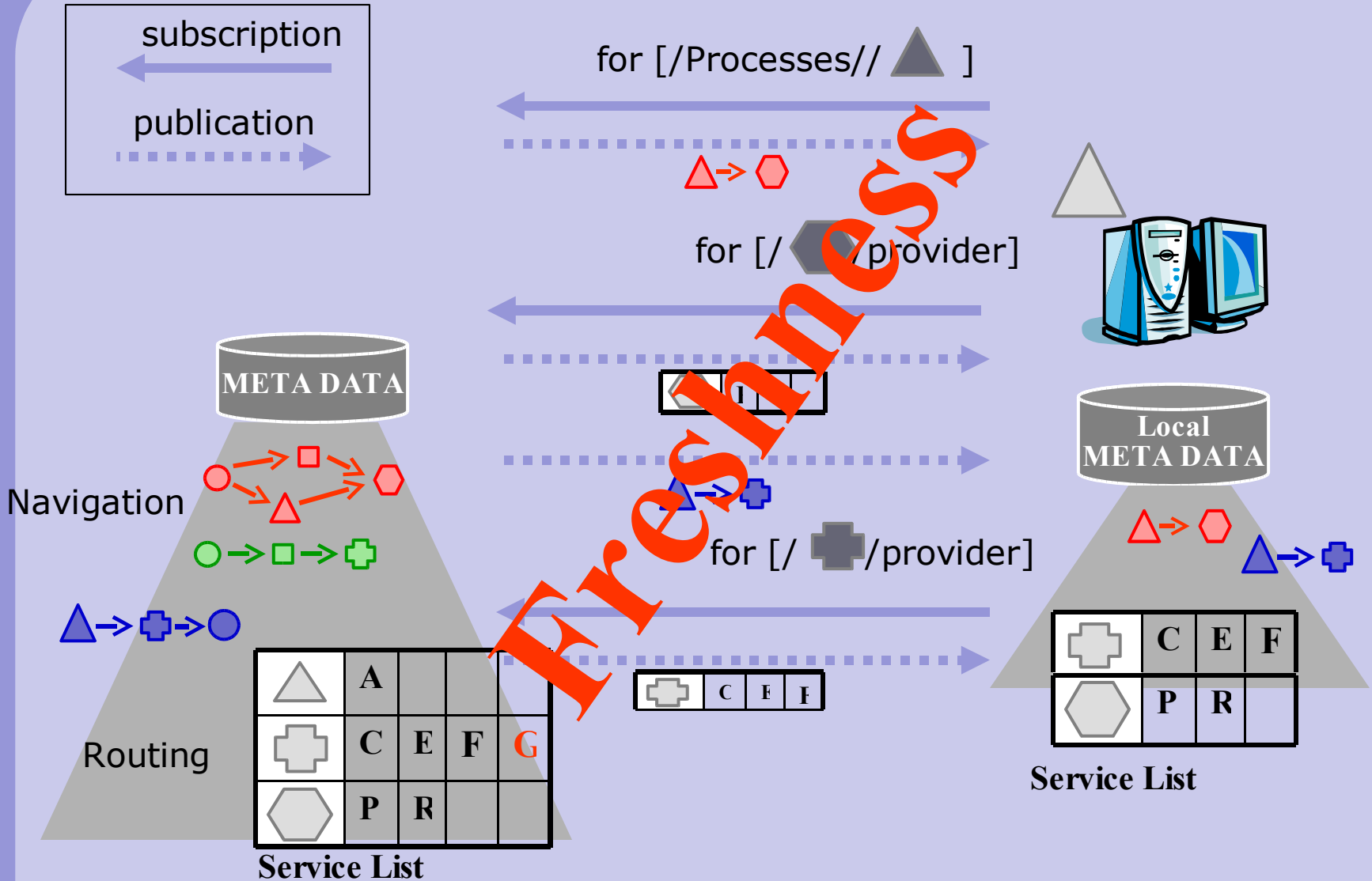
Workload Load Balancing
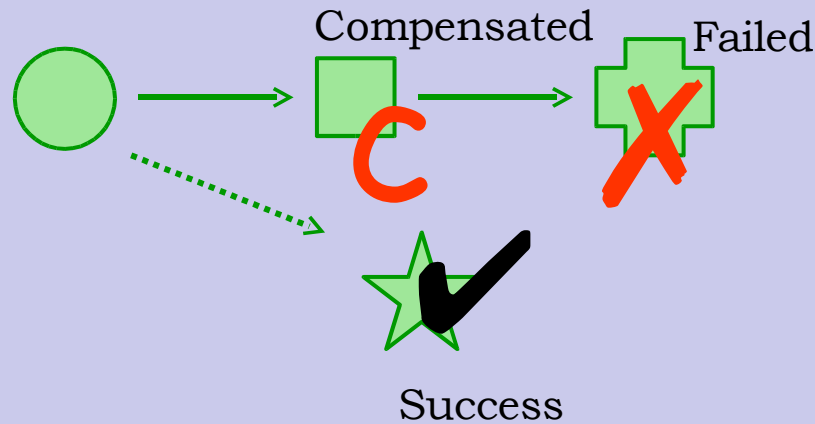
subscription

Load Repository

subscription

Load Information
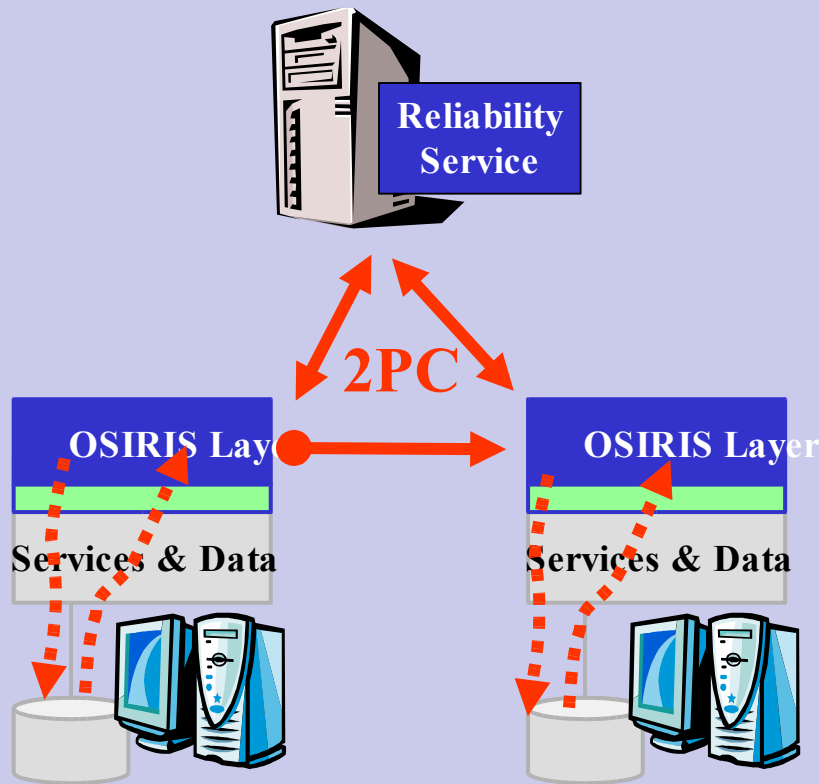
???

- Workload balancing allows for selecting optimal service provider

- Exploit workload information to route process instance.

- Workload information must be locally available.

- Global **load repository** subscribes for significant changes of provider workload

- And **publishes** global changes to peers

OSIRIS Open Service Infrastructure for Reliable and Integrated Process Support

Providing "Database like" Guarantees

Compensated   Failed
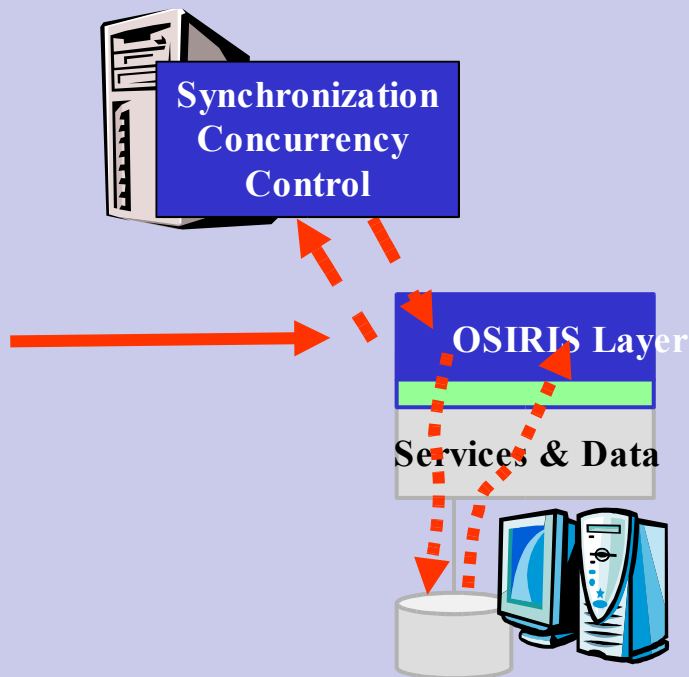
C   **X**

Success

- **Transactional Processes**
  - **Guaranteed Termination**
  - **compensation and alternative execution paths**

- Persistent process routing
  → 2PC Protocol from Peer to Peer
  → Reliability Service

- Concurrency Control on Service level
  → Intercepting Service Call
  → Global Concurrency Control Service

Providing "Database like" Guarantees

Reliability Service

2PC

OSIRIS Lay

OSIRIS Layer

Services & Data

Services & Data

- Transactional Processes
  - Guaranteed Termination
  - compensation and alternative execution paths

- **Persistent process routing**
  - → **2PC Protocol from Peer to Peer**
  - → **Reliability Service**

- Concurrency Control on Service level
  - → Intercepting Service Call
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OSIRIS Open Service Infrastructure for Reliable and Integrated process Support

Providing "Database like" Guarantees

Synchronization Concurrency Control

**OSIRIS Layer**

Services & Data

- Transactional Processes

  - Guaranteed Termination

  - compensation and alternative execution paths

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  - → 2PC Protocol
  - → Reliability Service

- **Concurrency Control on Service level**
  - → **Intercepting Service Call**
  - → **Global Concurrency Control Service**
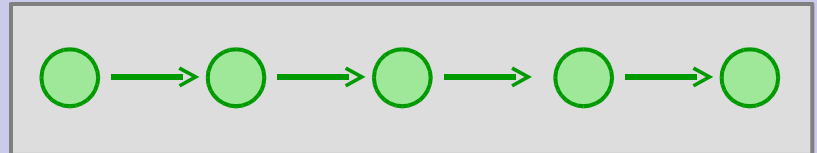
OSIRIS: The big Picture
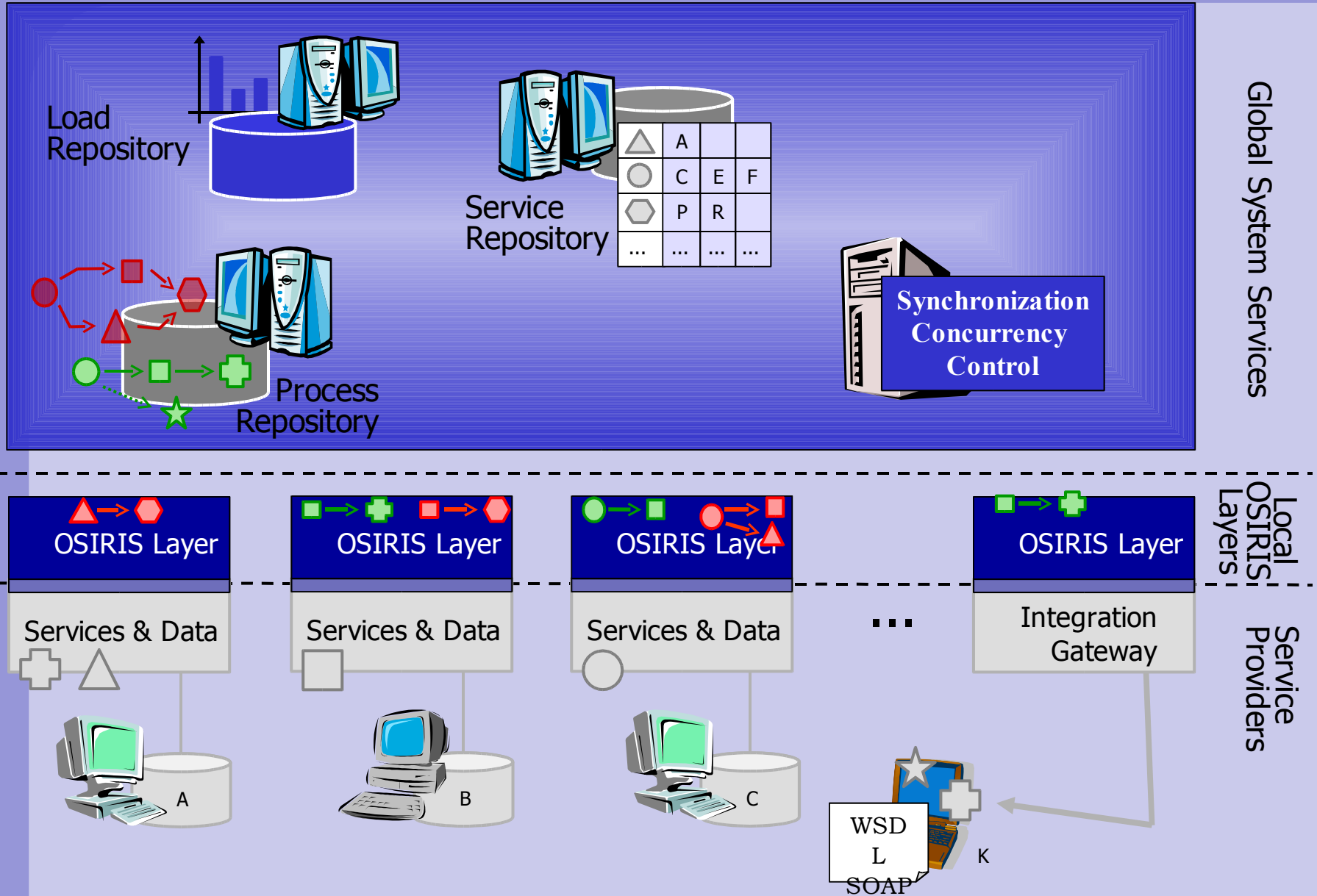
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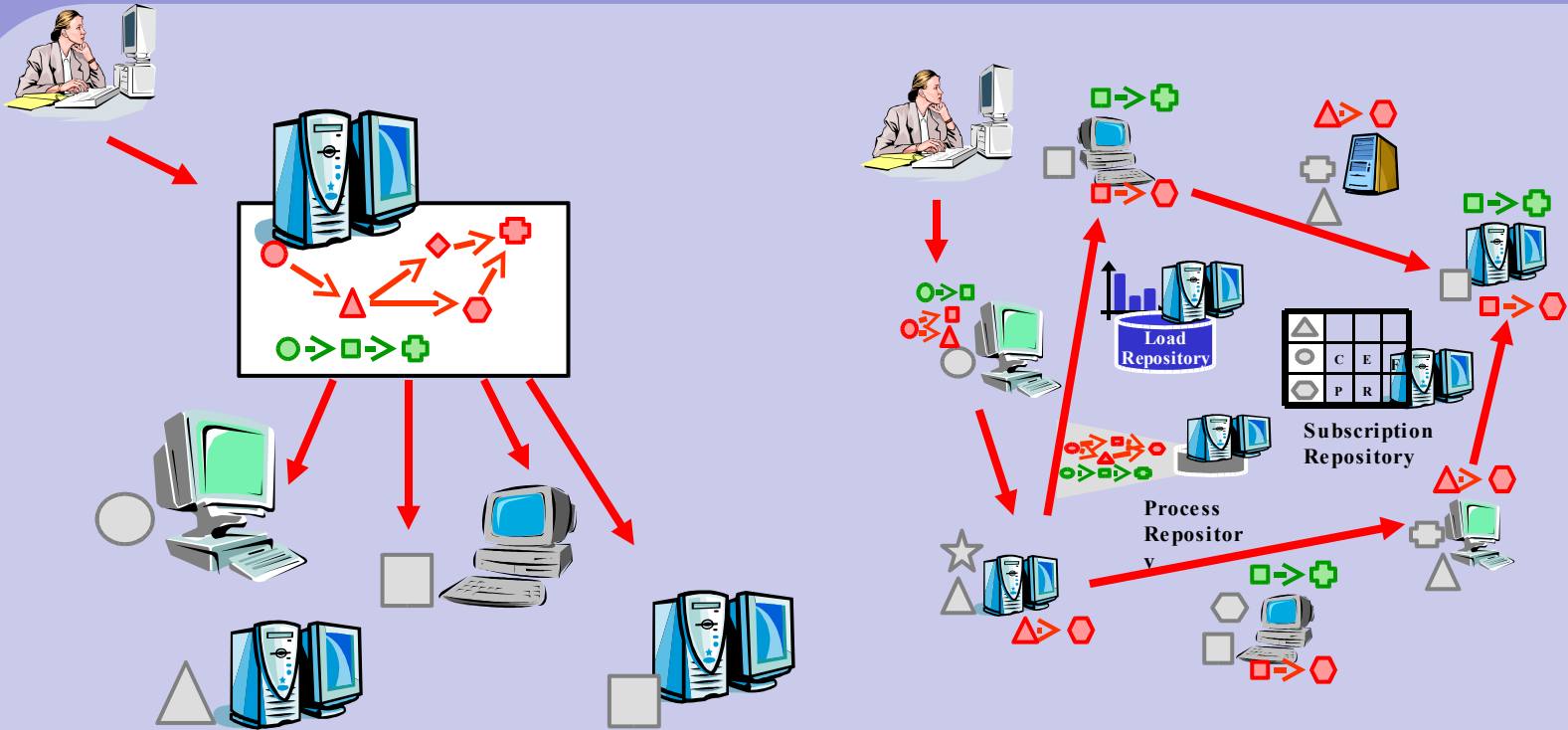
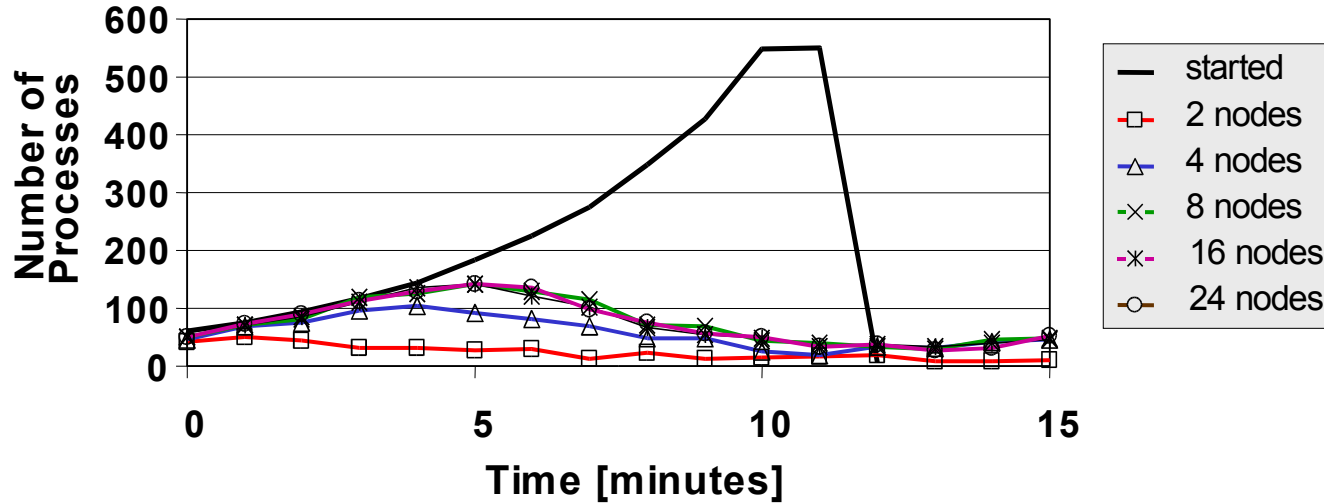- **Centralized vs. Peer-to-Peer process execution**
  - One basic process type
  - Every activity takes 2s

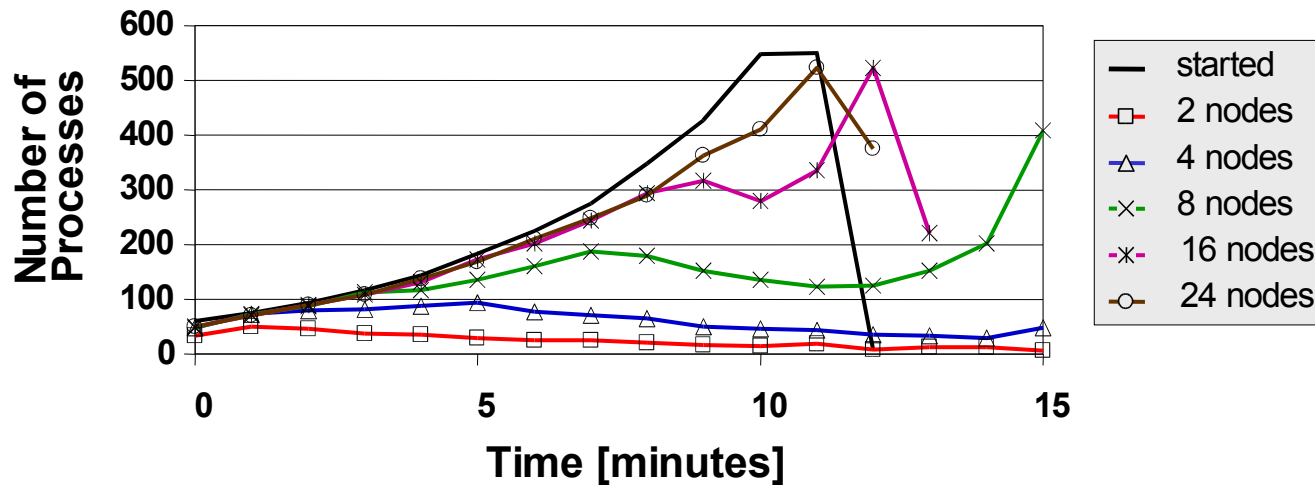 - Increasing number of providers and processes

Process Throughput – Centralized vs. Peer-to-Peer
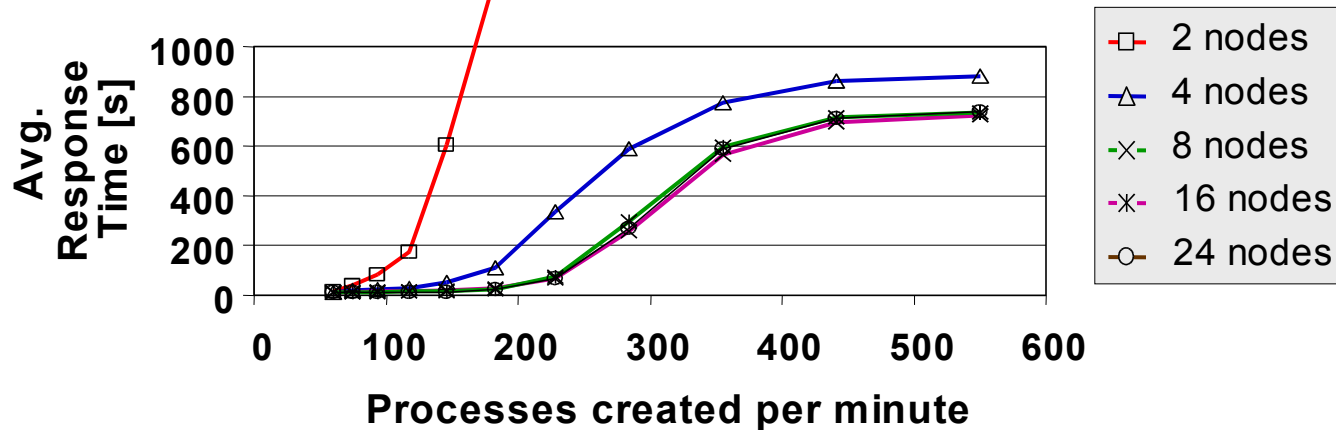

Central

- Increasing overall load in the system

- **Centralized Approach**: with 8 nodes, the limit of scalability is reached

- **OSIRIS (P2P)**: scales well, already 16 peers sufficient to cover the full load
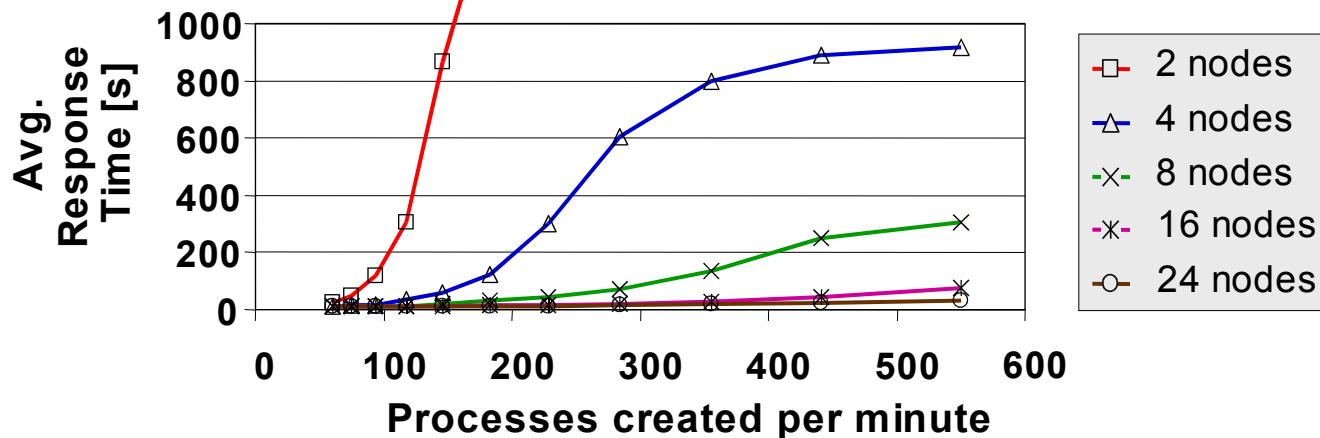

OSIRIS

Process Response Times – Centralized vs. Peer-to-Peer

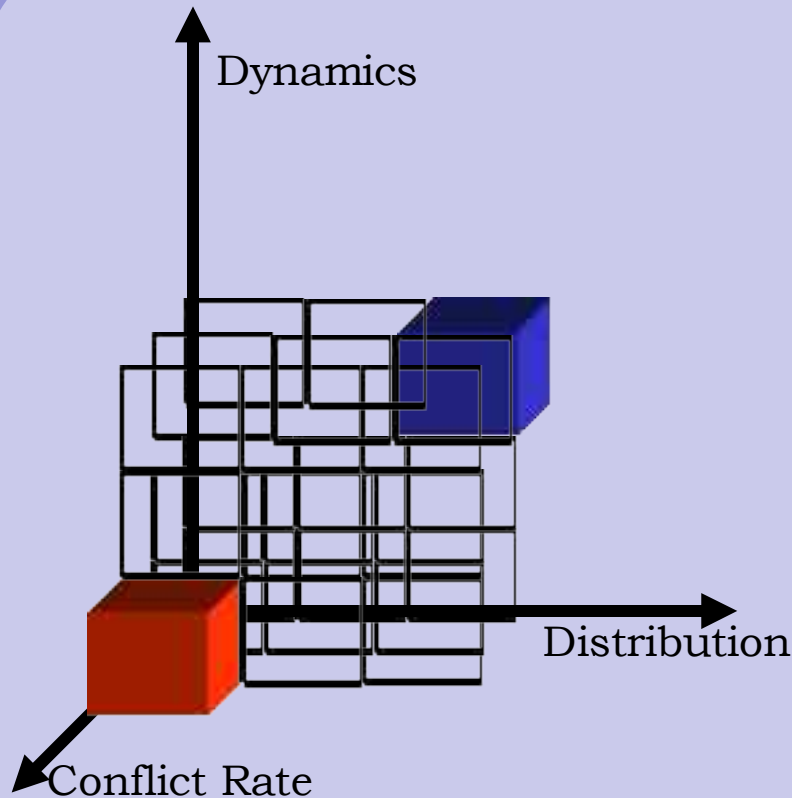**Central**

OSIRIS

- **Same scenario than before**

- **Centralized Approach:** coordinator as bottleneck – adding more than 8 nodes will not further decrease avg. response time

- **OSIRIS (P2P):** no bottleneck, almost perfect scalability

- Dramatically increasing number of services and processes in the internet need a new architecture to high scalability.

- Combining ideas from different areas together with a sophisticated replication mechanism allows for realizing a truly distributed peer-to-peer process management system.

- The OSIRIS infrastructure has a high potential to **scale** with respect to increasing **number of providers** as well as to increasing **number of processes**.

- Applied to Information Space Management of ETHWorld (Virtual Campus of ETH Zurich)

- First evaluation results presented here support the scalability predictions.

OSIRIS Open Service Infrastructure for Reliable and Integrated process Support

Dynamics

Distribution

Conflict Rate

- A more complex benchmark setting will show, for what class of application OSIRIS architecture is best suited.

- What concepts can be applied to partially improve existing approaches.

  - Service GRID infrastructure

  - Central process management

- Acknowledgment: Work supported by the IBM Labs Germany, Böblingen with a IBM Hardware SUR Grant

Thank you …   **Questions?**