Towards Scalable Online Interactive Applications on Grids and Clouds

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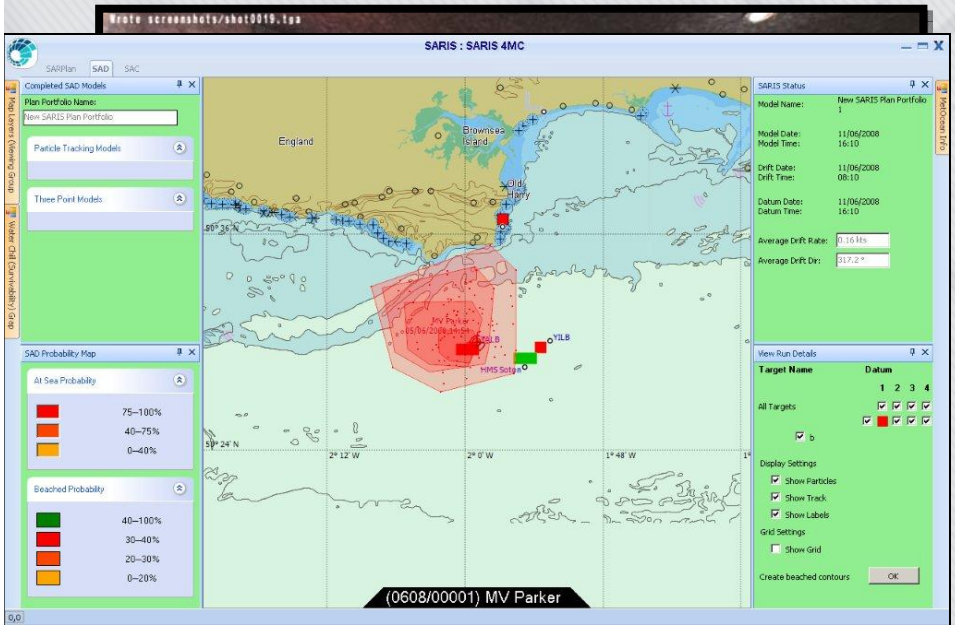
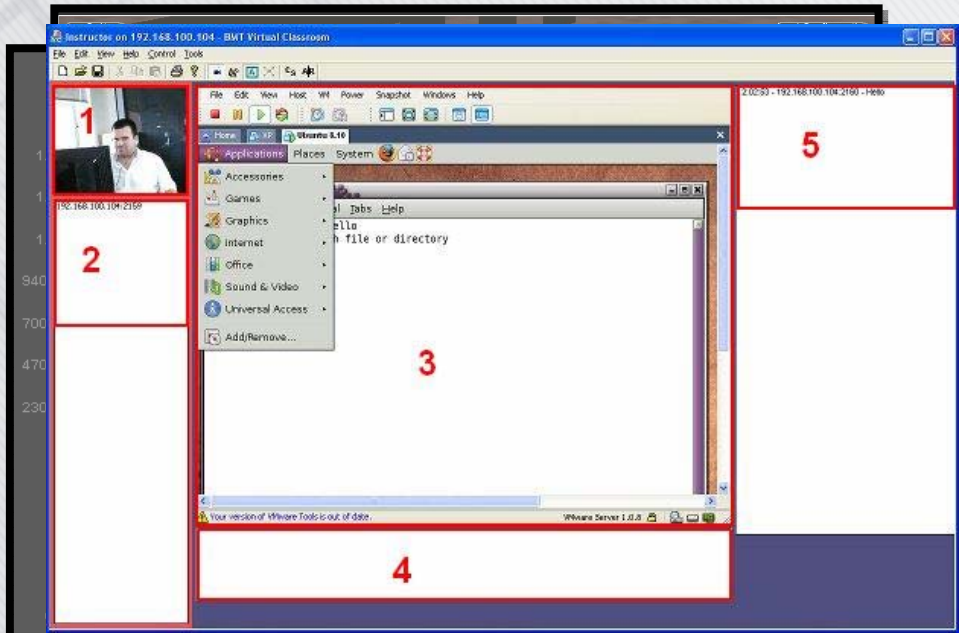
Real-Time Online Interactive Applications: ROIA

<u>Apps</u>*:* Online games, Interactive e-learning, Distributed simulations,…

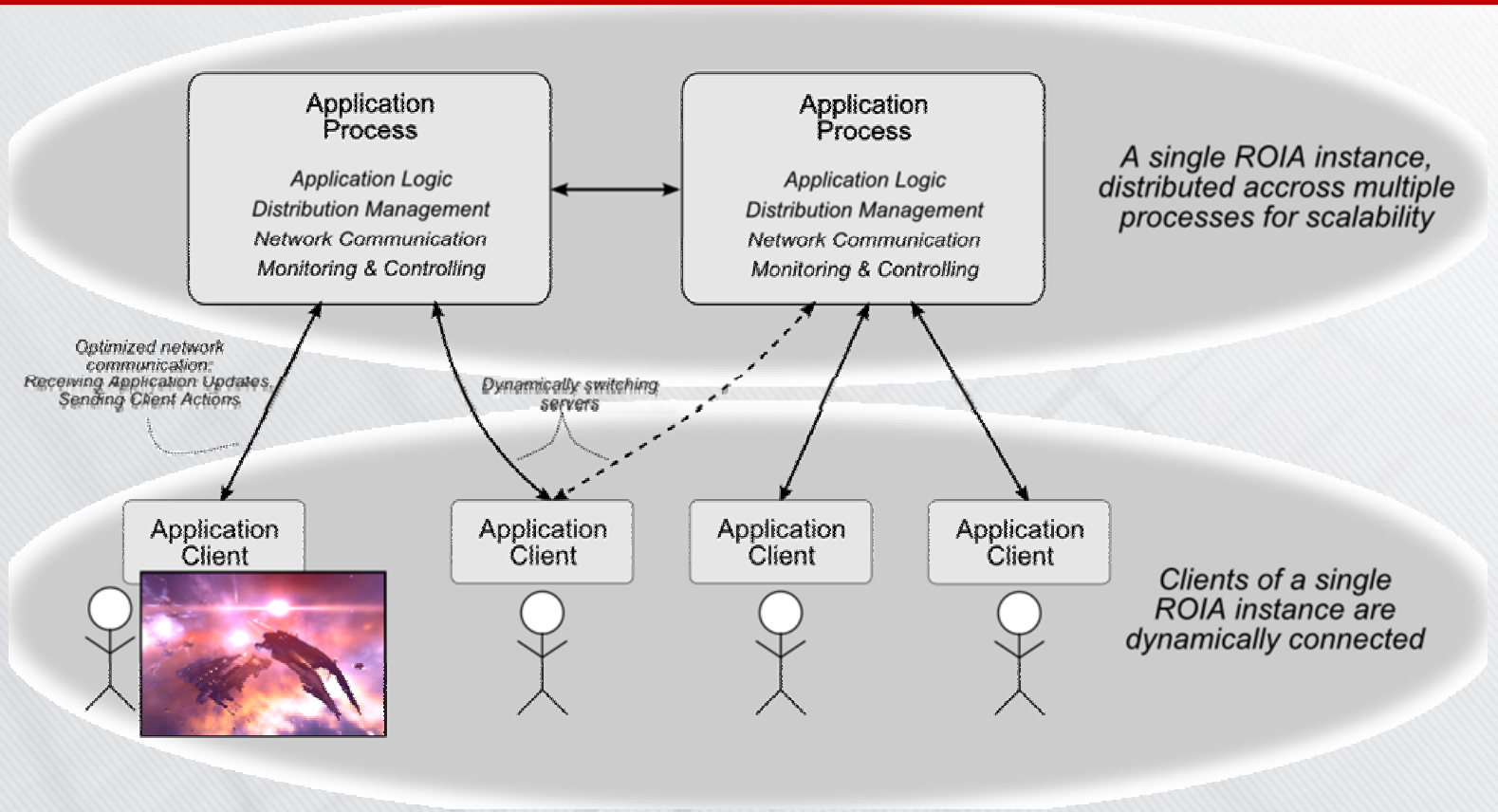
- **Huge numbers** of concurrent users to a single application instance (> 40.000 simultaneous participants in Eve Online),
- **High update rate** of the application state (5-100 updates/sec),
- **Short response time** to actions (< 100ms), despite slow Internet links,
- **Variable load**: daytime-dependent,
- **Trust and security**: new challenges, e.g., cheating.

Main Challenge – Scalability!





Basic Picture of a ROIA Service Instance



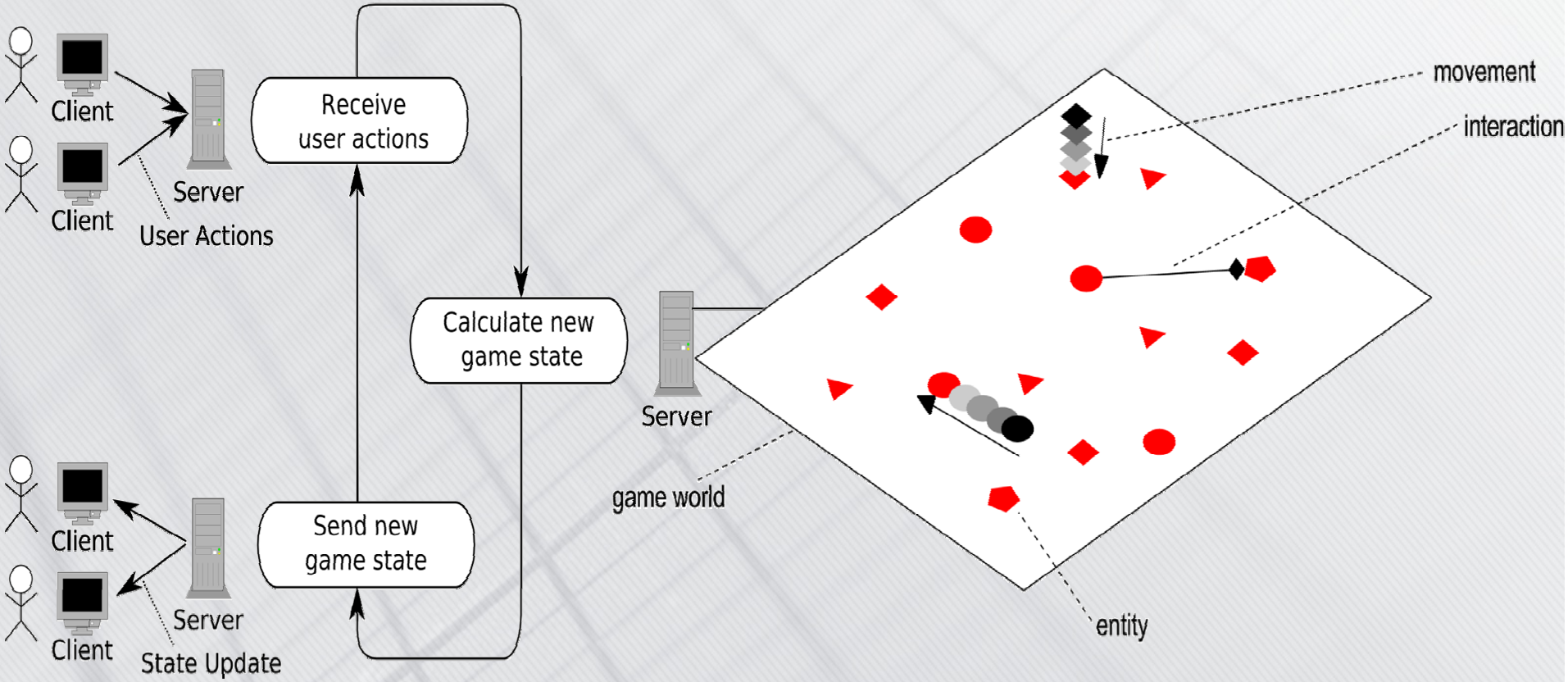
untime Characteristics of ROIA Services:

- ultiple servers for a single application -> **parallelism + communication**
- lients are (re)connected to servers -> **data (re)distribution + scheduling**

Real-Time Loop in Multiplayer Games

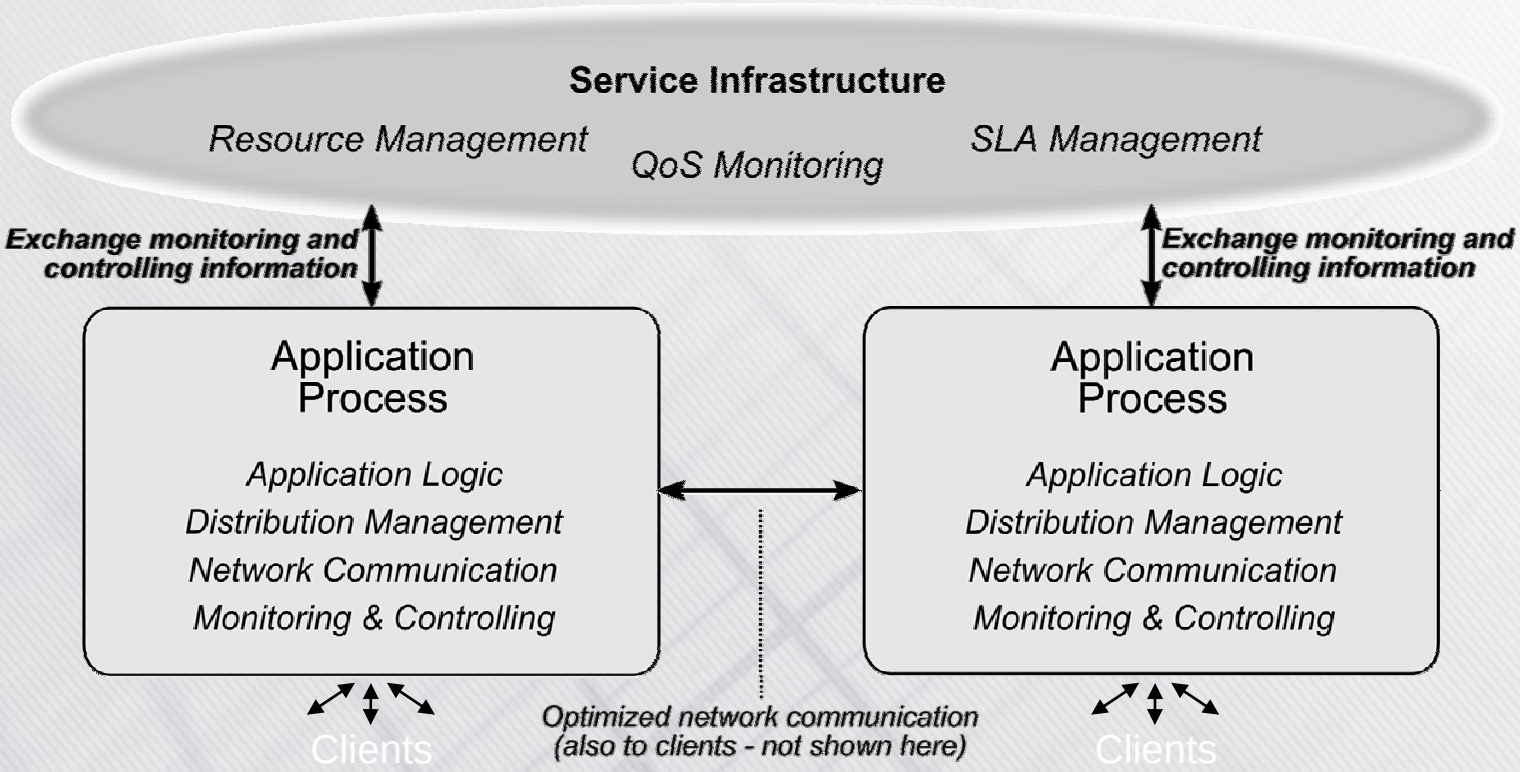
A model for Virtual Environment processing: Real-Time Loop

- Operated with high frequency (5-100Hz), in (soft) real time



1. Transfer user actions from the clients, receive in the servers
2. Process the new game state: apply game logic, move entities
3. Transfer the game state update to the clients

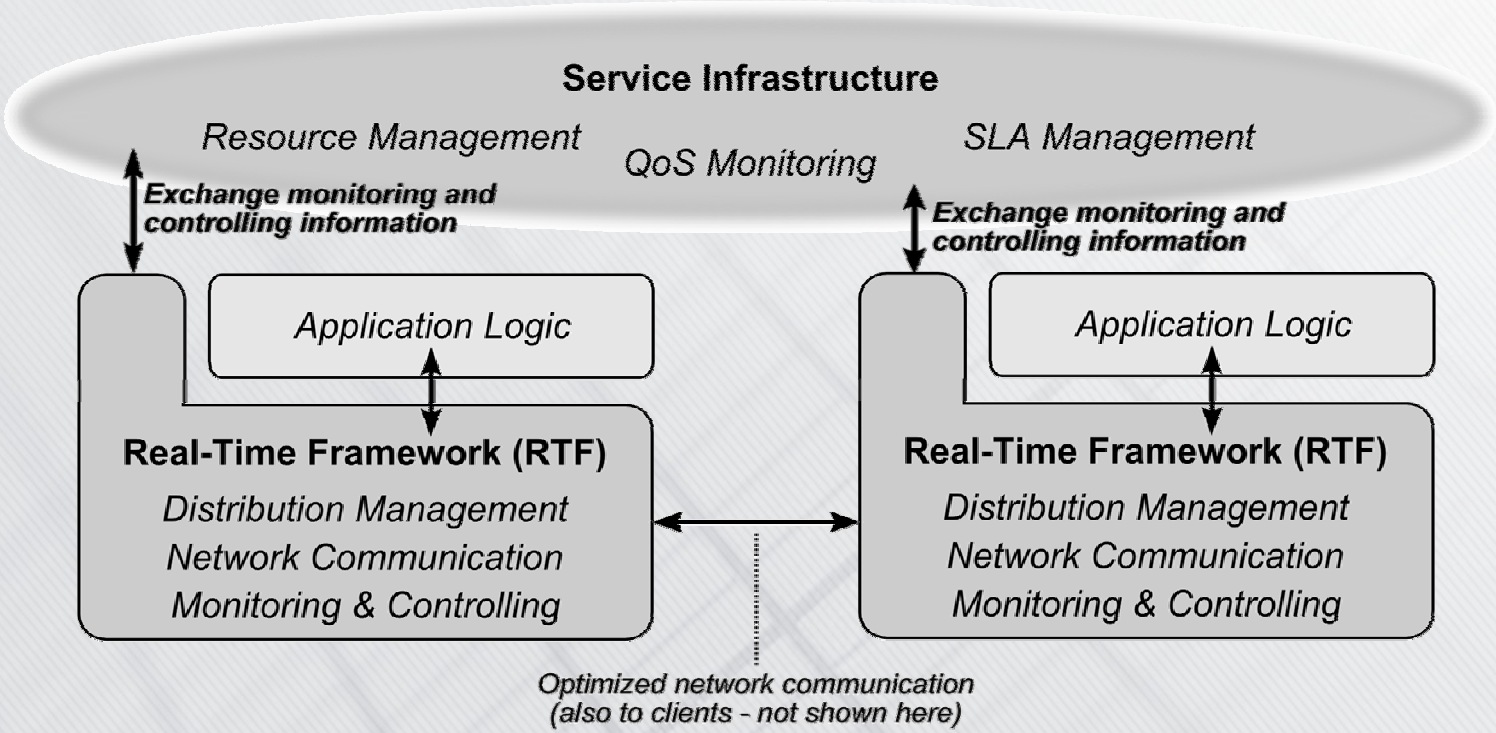
ROIA Development and Provision



urrent ROIA development:

- hoose a distribution/parallelization concept
- reate & maintain a customized run-time monitoring/controlling
- **RTF liberates developer from these cumbersome tasks…**

The Real-Time Framework (RTF)

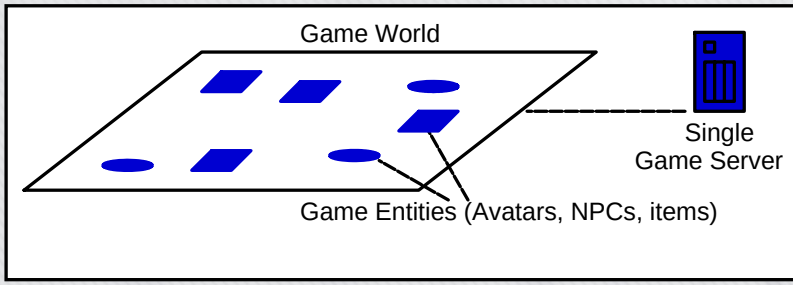


RTF is a high-level development API & runtime environment that enables:

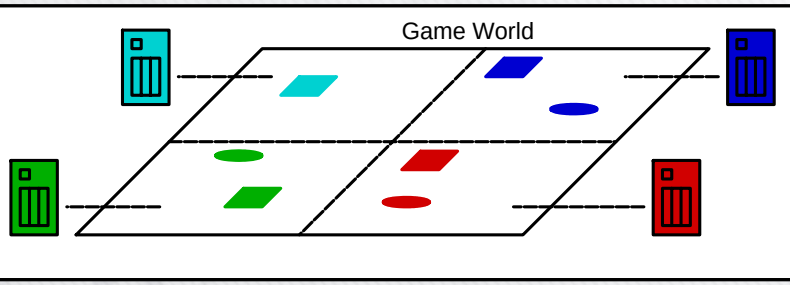
- Simplified app. development via parallelization and distribution techniques.
- Hiding and optimizing communication & synchronization (sockets in C++).
- Scalable and seamless use of resources (servers).
- Service adaptation and QoS for a changing user demand.

Distributing the ROIA State for Parallel Processing

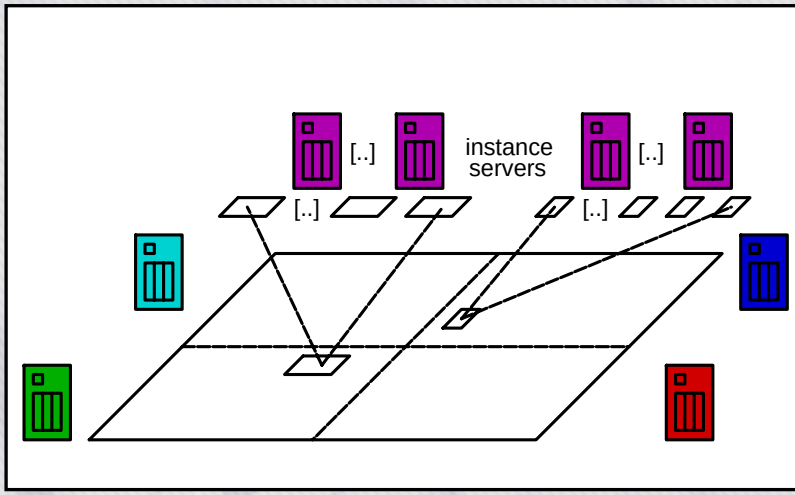
- RTF supports a variety of distribution/parallelization approaches and allows the developer to combine different distributions



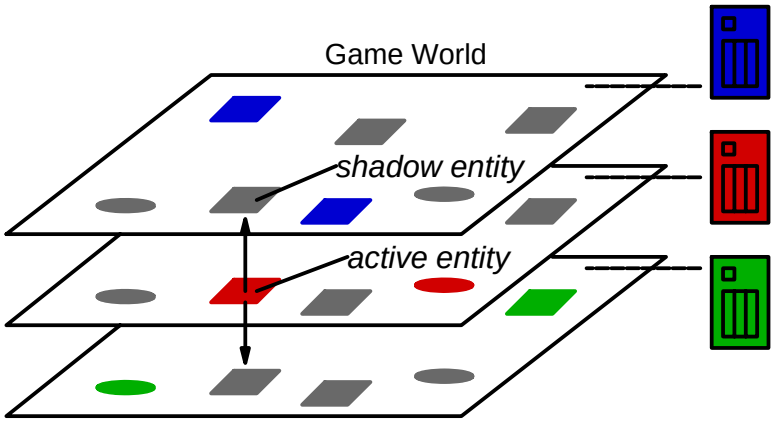
Basic Single Server



Multi-Server Zoning

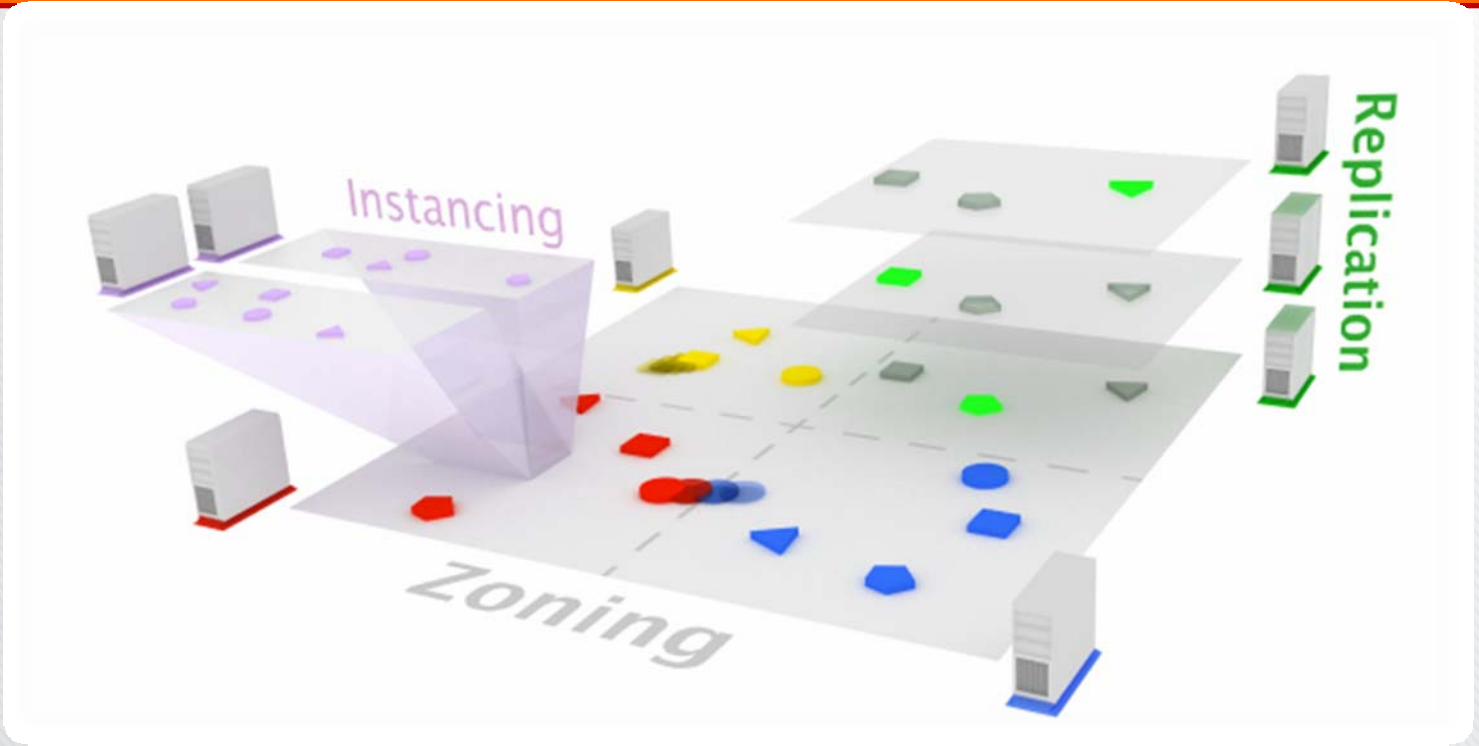


Multi-Server Instancing



Multi-Server Replication

Combining the Distribution Concepts



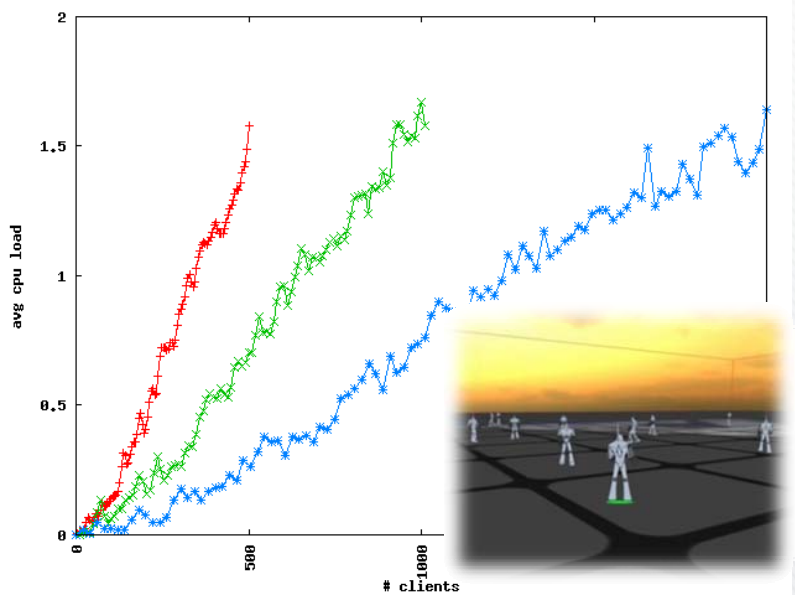
- **RTF supports** all three distribution concepts *and their combinations*
- **Developer's role:** to define zones and their possible replication
- **RTF's role:** to automatically manage distribution, parallel computation of entities and all necessary communications
  - (re)assignment of zones to the servers during runtime in a seamless way for the developer and user, ensuring scalability (higher # users)
  - management tasks are performed by RTF, e.g. monitoring

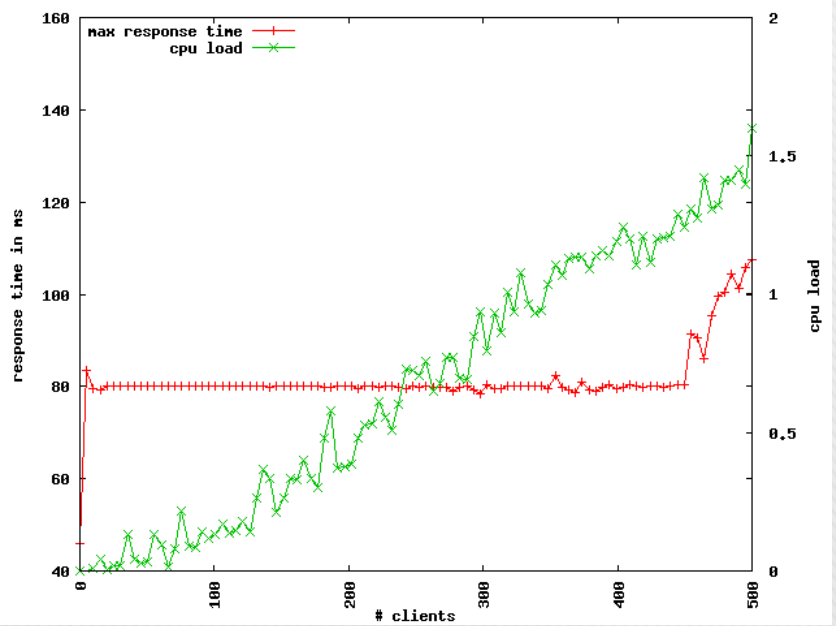
RTFDemo Scalability Results (1/2)

- Tests with RTFDemo, a fast-paced First-Person-Shooter game:
  - Server real-time loop runs at 25 Hz
  - Clients are bots moving randomly and shooting at opponents in sight
  - Clients do not notice that they play in a multi-server environment

- Zoning scalability results:
  - RTF scales nearly linearly with the number of zones
  - Up to 1800 simultaneous clients with four zones/servers
  - Response time stays stable to up to ~450 clients per server

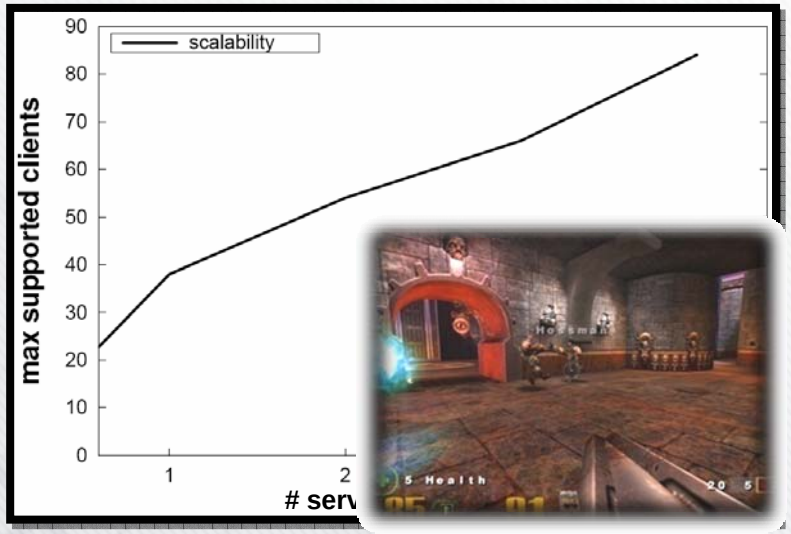
Response time *= time between client's action and server's response to it*



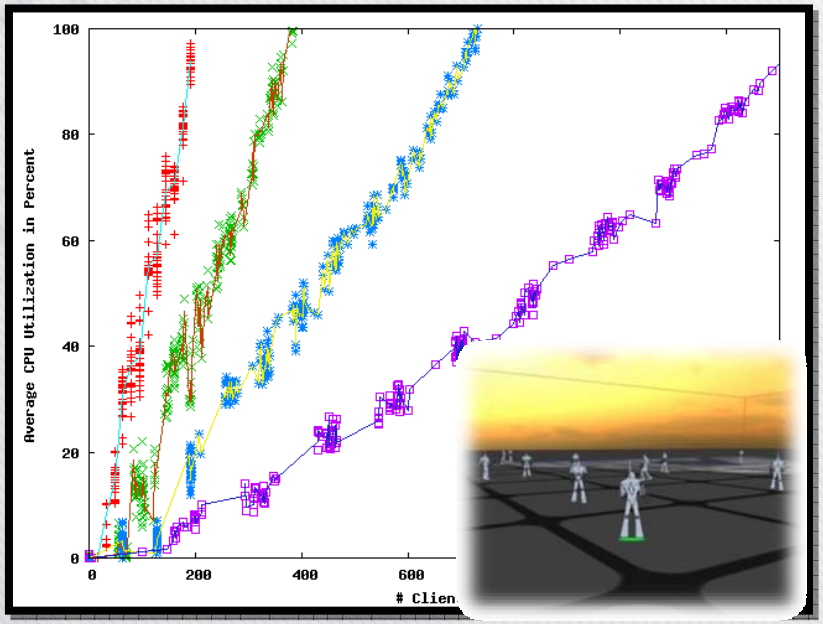


Evaluating RTF's application scalability

- Replication scalability test: Quake 3 on top of RTF
  - RTF allows to scale Quake 3 and to increase the number of players
  - Players do not notice that they now play in a multi-server environment



- Zoning scalability test: Custom FPS with all typical game elements
  - Server real-time loop runs at 25 Hz
  - Clients are bots moving randomly and shooting at opponents in sight



Using Elastic Cloud Computing for ROIA Provisioning

OIA characteristics differ from classical Grid applications:

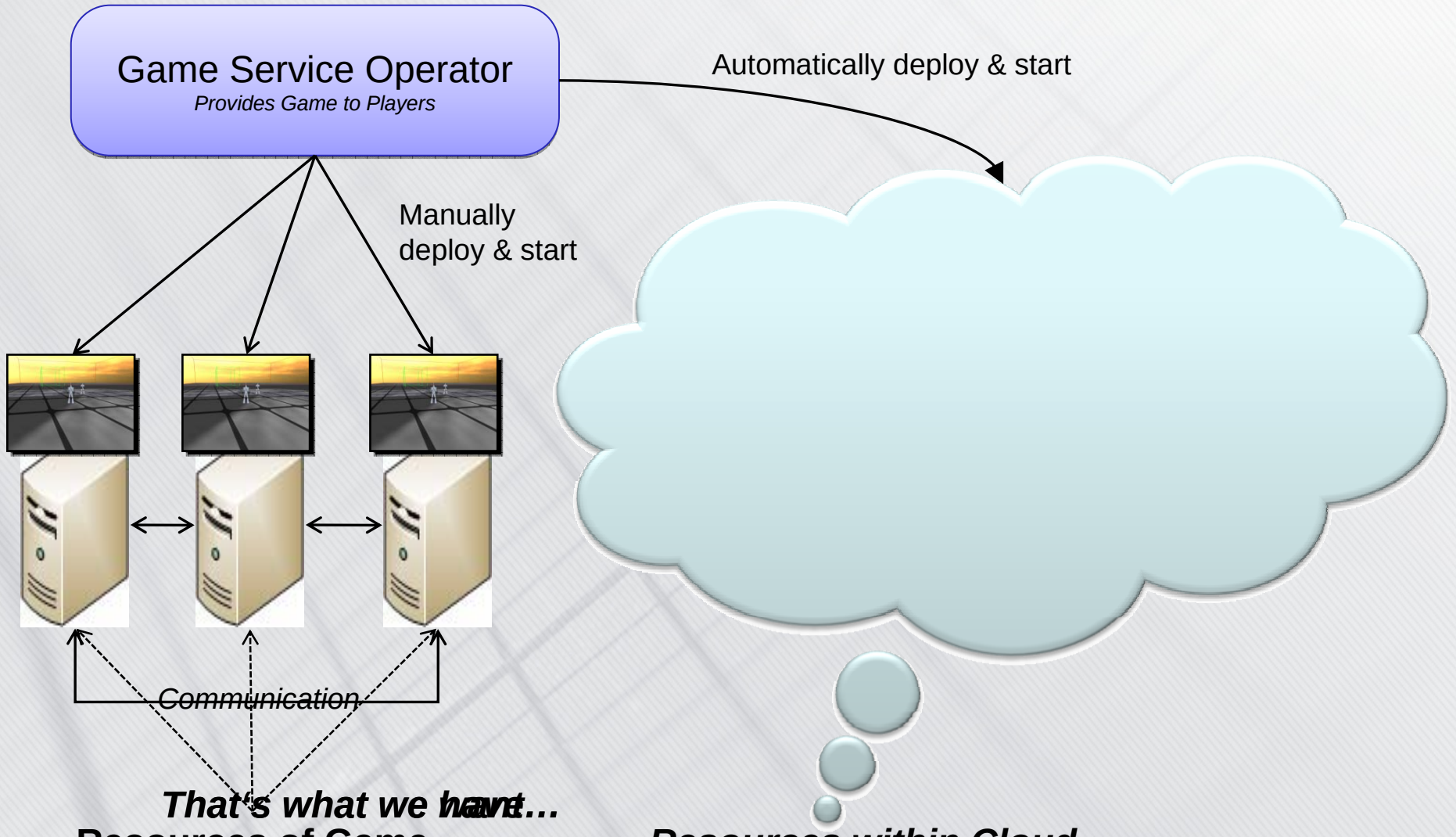
- **hanging user numbers** during runtime
- **ynamic user base** with changes of orders of magnitude
- **eographic distribution** of workloads due to users connecting from arbitrary world-wide locations but sharing the same application instance
- **ingle-hoster service provision** is often inflexible and cost-ineffective

Approach: Exploit characteristics of Cloud and IaaS:

- Provide dynamic server resources on-demand
- Scale applications using RTF to become massively multiplayer

ROIA have extremely dynamic distributed workloads that are difficult to host **cost-effectively** on static Grids

Short illustration…

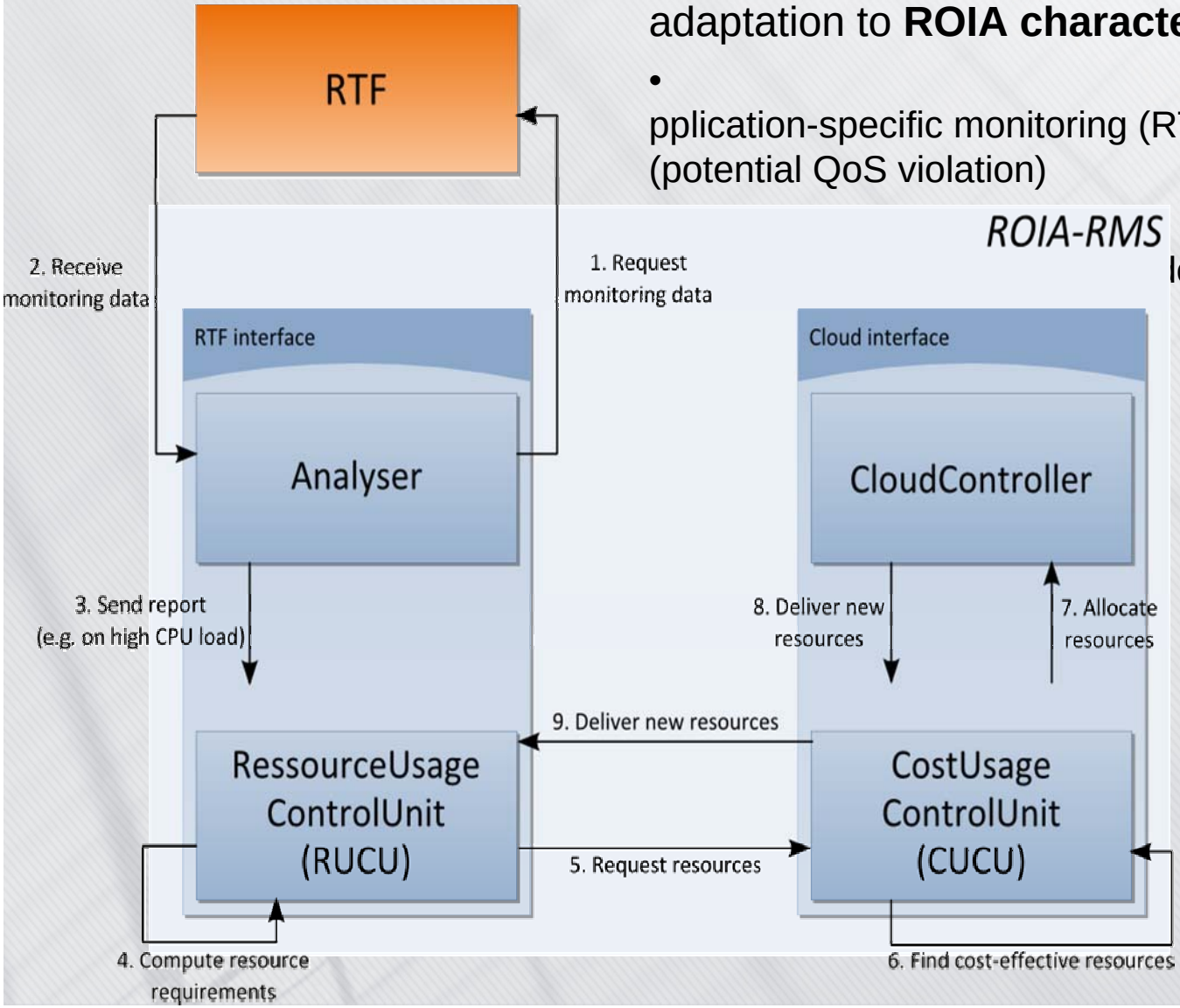


ROIA Resource Management System for Clouds (ROIA-RMS)

esource Provisioning in Clouds with particular adaptation to **ROIA characteristics**

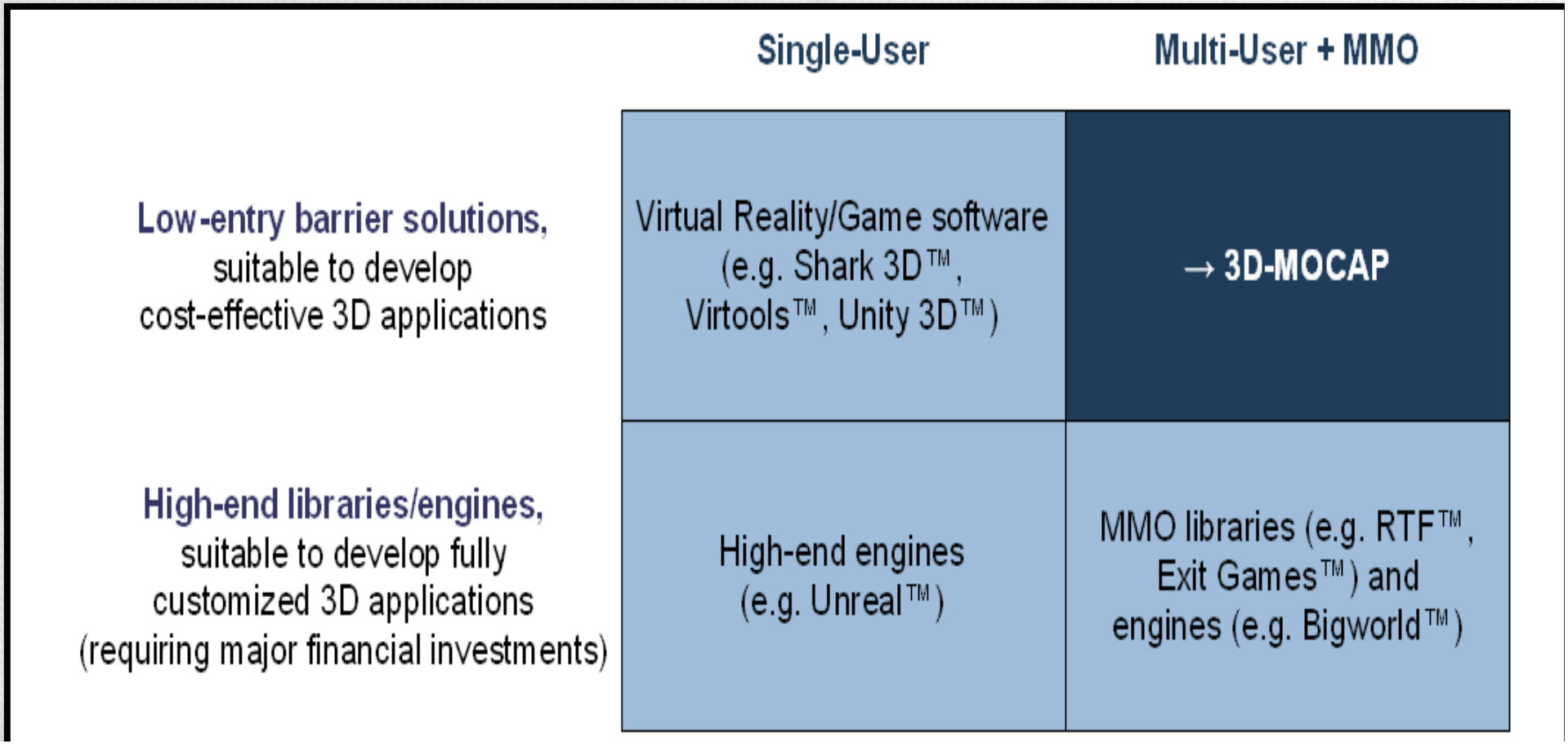
- pplication-specific monitoring (RTF) reveals bottlenecks (potential QoS violation)

lers w.r.t. cost-efficiency



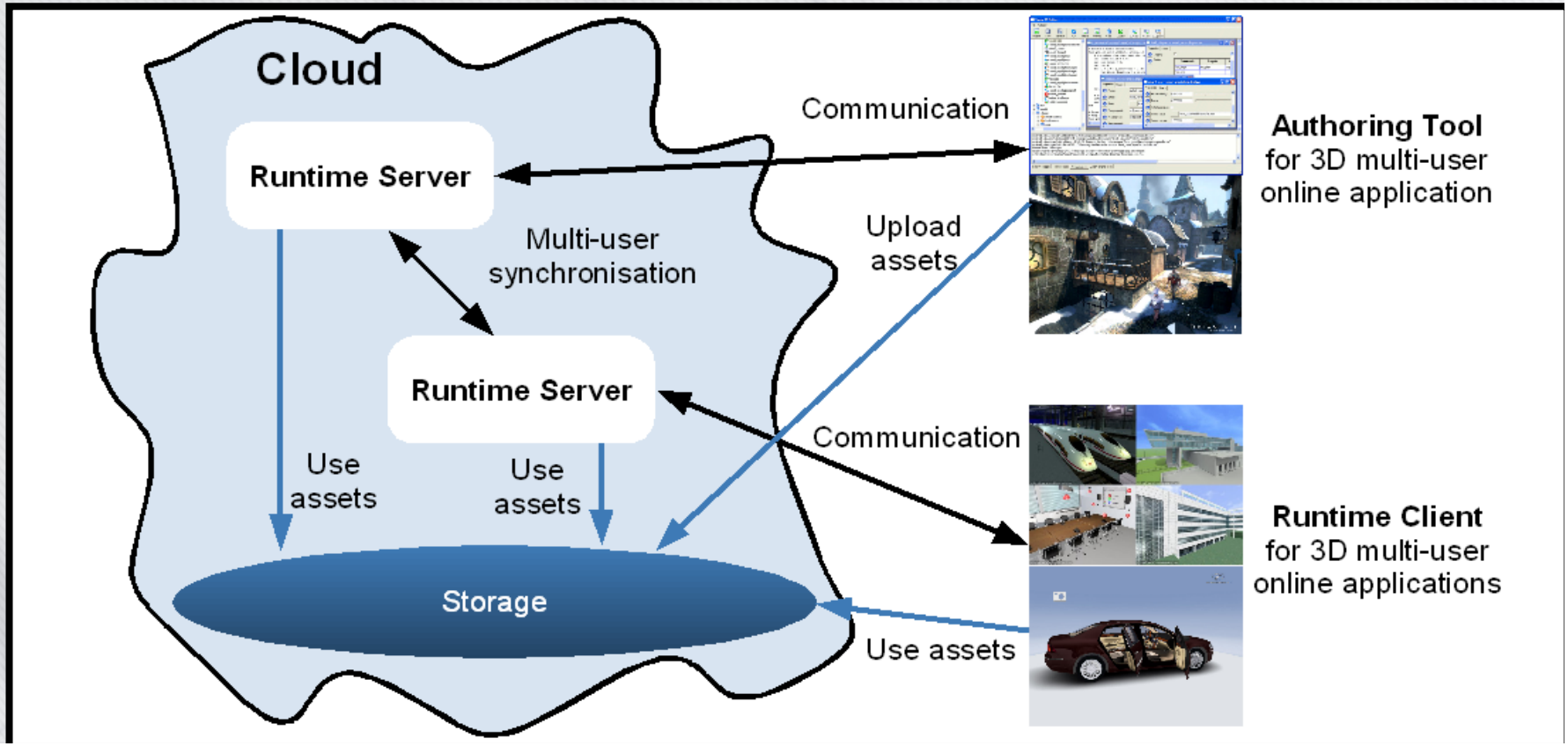
Industrial Cooperation

- **D Multi-User Online Cloud Authoring Platform (3D-MOCAP)**
  - Cooperation with **Spinor GmbH**, specialized on authoring systems and 3D engines (Shark 3D™) for computer games, simulations, etc.
  - Target: Cloud-based authoring system for multi-user 3D applications

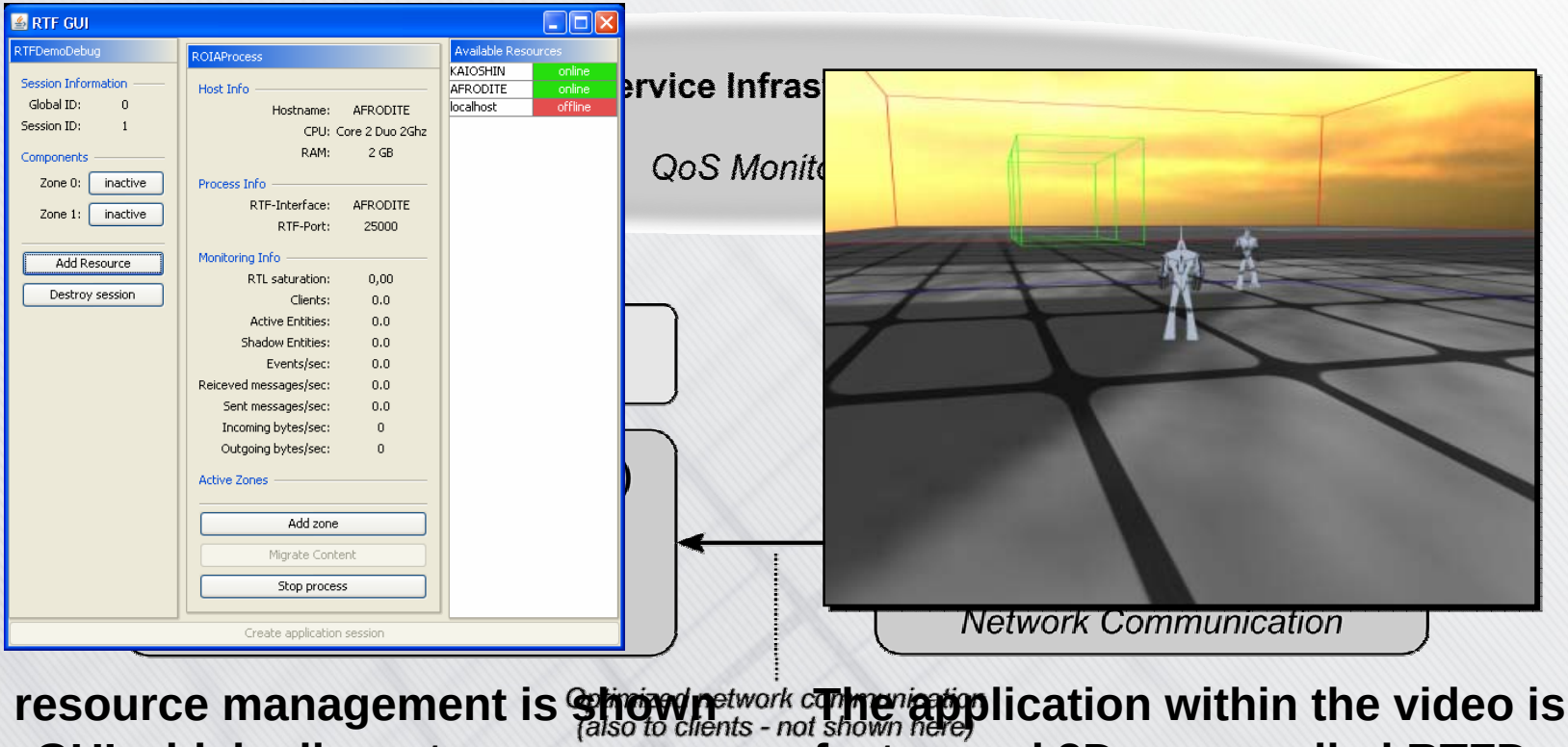


3D Multi-User Online Cloud Authoring Platform

- 3D multi-user online application with 3D-MOCAP
  - Application servers are running on **Cloud resources**
  - Application-specific assets are stored in **Cloud Storage Service**
  - **RTF** is used for communication and workload (re)distribution
  - Modifying applications at runtime by changing assets with **Authoring client**



A Demonstration of RTF



The resource management is shown via a GUI which allows to:

- Monitor the application service
  - Network characteristics
  - Event and client count
  - Saturation, etc.
- Add resources during runtime
- Redistribute load during runtime

The application within the video is a fast-paced 3D game called RTFDemo

- Clients have an avatar (robot) and move within the world
- They can shoot at each other's avatar
- Zoning and replication within RTF is used to scale RTFDemo