SCALABLE DYNAMIC SYNTHETIC ENVIRONMENTS USING A NEXT-GENERATION GAME ARCHITECTURE

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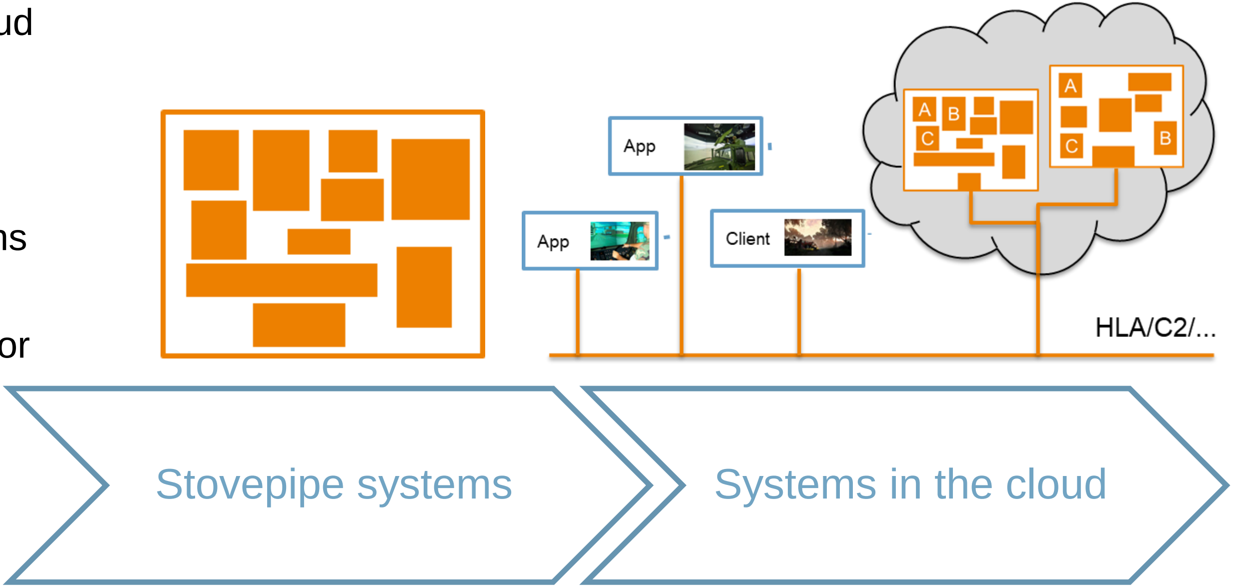
Image: Crackdown 3 - Pre-alpha in-game footage

CURRENT STATE OP PLAY

Moving existing systems to the cloud

+ Centralized resources
+ “Reusable”
- Still large monolithic applications
- Not really (micro)services
- Hard to change specific behavior



Stovepipe systems

Systems in the cloud

GAMING TRENDS

- Agile development – daily releases
- Cross-platform play
- Cloud integration (game server, physics service, …)
- Massive (destructible) game worlds

- Cloud-based game development platforms
  - Cloudgine: Crackdown 3 w. Microsoft Cloud
  - SpatialOS
  - Amazon Gamelift
  - Coherence
  - Unity – Connected Games services

SpatialOS

unity

AMAZON GAMELIFT

Dedicated game server hosting made easy

UNREAL ENGINE

coherence

cloudgine

lumberyard

amazon web services

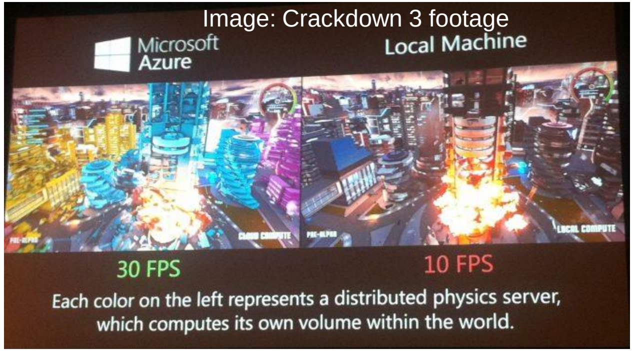
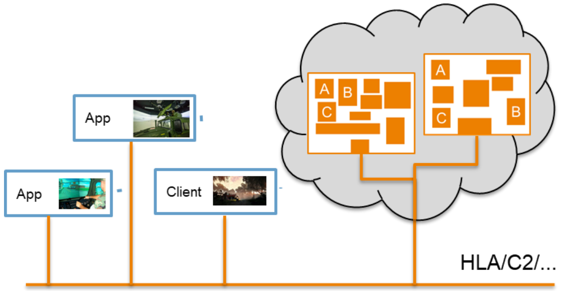
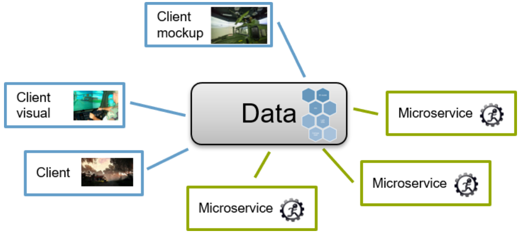


Image: Crackdown 3 footage

Each color on the left represents a distributed physics server, which computes its own volume within the world.

VISION





Stovepipe systems

Systems in the cloud

Component-based systems and services in the cloud

Next-gen architecture using microservices

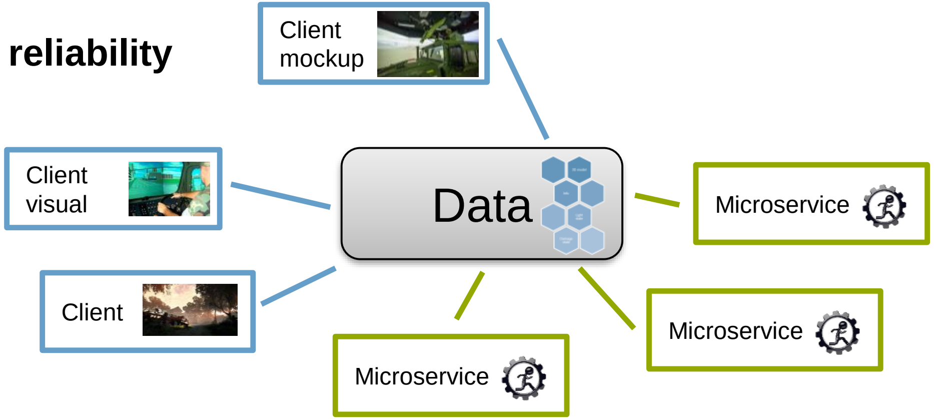
MSaaS vision

NEXT-GEN ARCHITECTURE USING MICROSERVICES

- Everything is a **entity**
- An entity is composed of reusable **components** (e.g. position, damage state)
- Entities live in the cloud (persistent!)

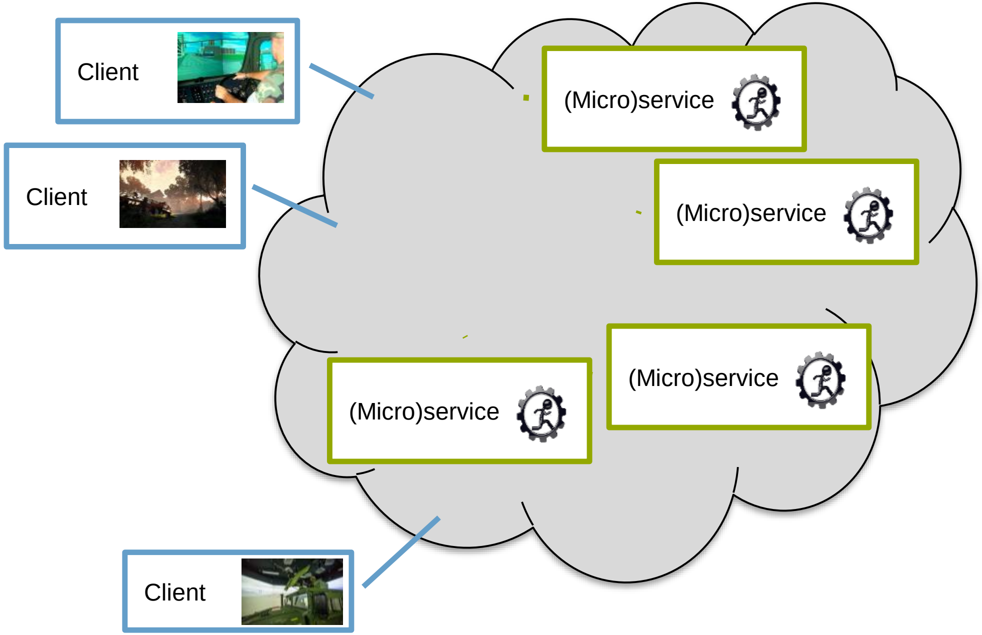
- **Microservices** modify components (movement model, physics simulation, …)
- Microservices interoperate via a **data model**
- “Data everywhere” abstraction
- Platform provides **load balancing, scalability and reliability**

- **Clients** can connect to the cloud anywhere and anytime (late joining)
- Local client (visual) is generated based on entities in view



MICROSERVICES - EXAMPLES

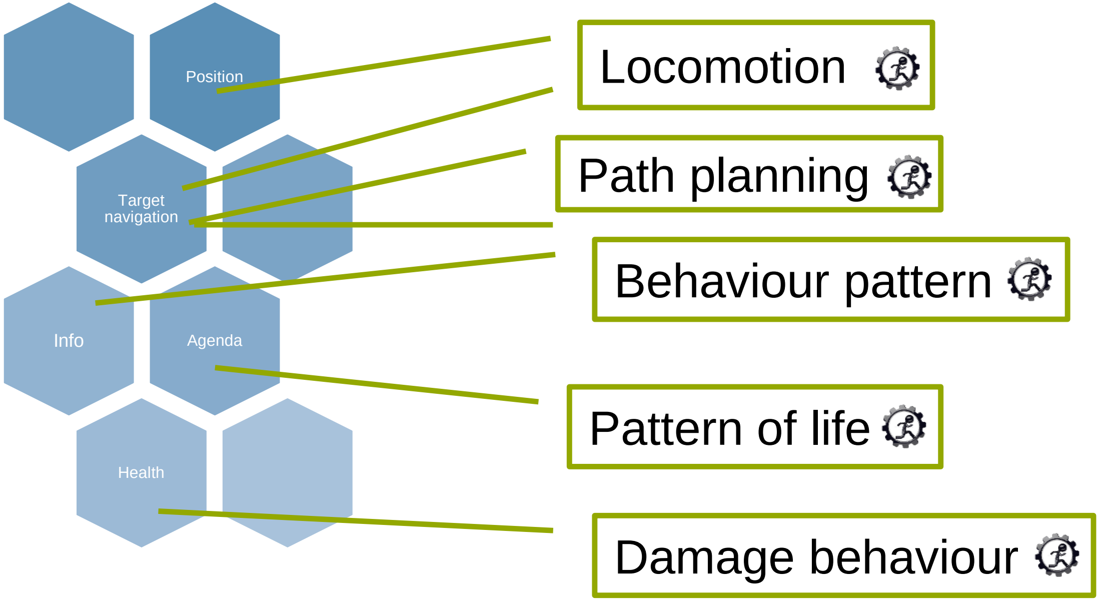
- Weapon service (missile trajectory, …)
- Weapon effect service (damage)
- Dynamic terrain service
- Route planning service
- Weather service
- Data recording service
- Performance evaluation service
- Mediation services (HLA-C2, DIS-HLA, …)
- …



ENTITY-COMPONENT-SERVICES EXAMPLES

NPC entity with components

Microservices



Position

Target navigation

Info

Agenda

Health

Locomotion

Path planning

Behaviour pattern

Pattern of life

Damage behaviour

DEMONSTRATOR - DYNAMIC DESTRUCTION

- Use case: fire support

- Features:
  - Geo-specific military training village (Altmark, Germany)
  - Terrain deformation (craters)
  - Object destruction
    1. Traditional model-switching
    2. Dynamic (physics) based destruction using NVIDIA Blast

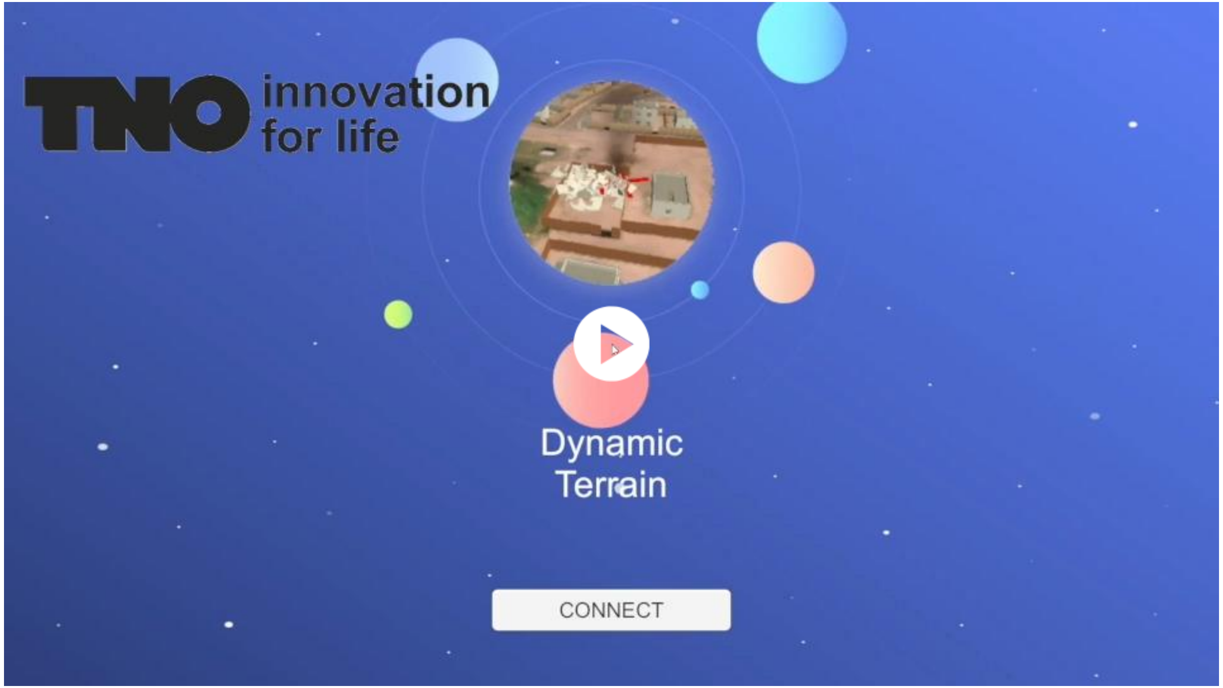
SpatialOS

unity

NVIDIA GAMEWORKS

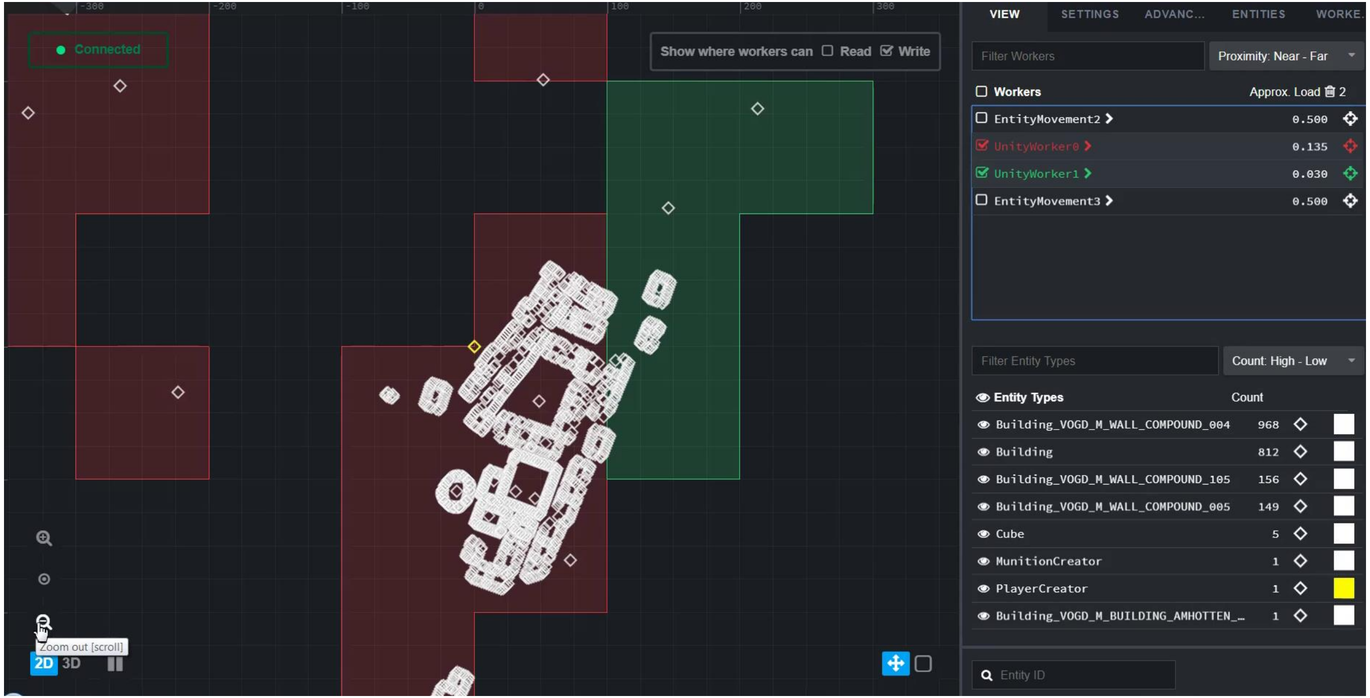
DEMONSTRATOR - DYNAMIC DESTRUCTION

SpatialOS



DEMONSTRATOR - DYNAMIC DESTRUCTION

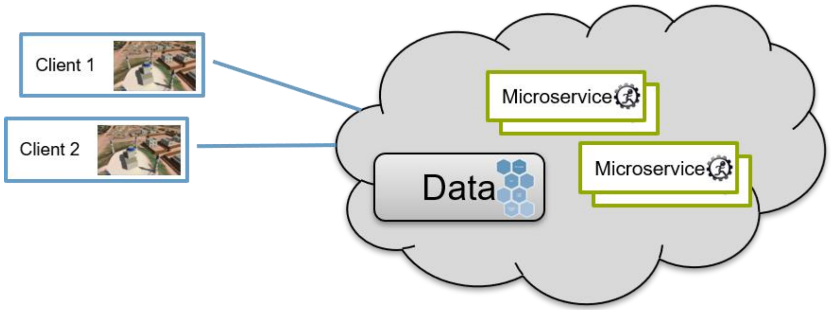
- 2100+ entities
  - 1273 wall segments
  - 813 buildings
- 215 unique 3D models



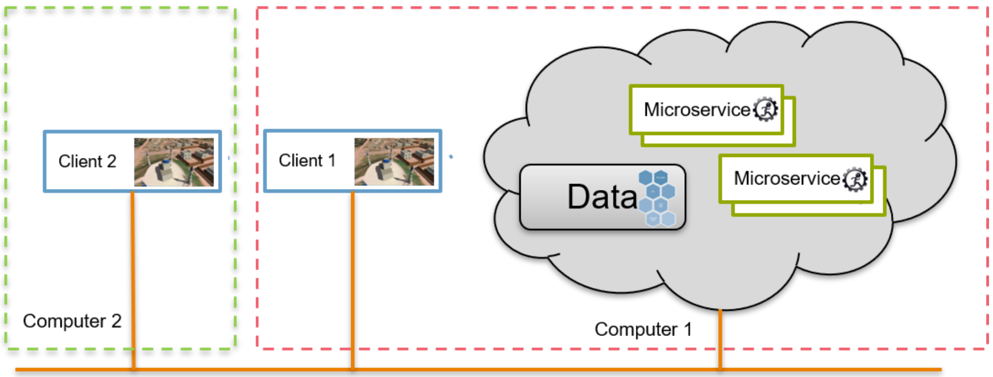
□ Workers	Approx. Load 🗑 2
□ EntityMovement2 ›	0.500
☑ UnityWorker0 ›	0.135
☑ UnityWorker1 ›	0.030
□ EntityMovement3 ›	0.500

Entity Types	Count
Building_VOGD_M_WALL_COMPOUND_004	968
Building	812
Building_VOGD_M_WALL_COMPOUND_105	156
Building_VOGD_M_WALL_COMPOUND_005	149
Cube	5
MunitionCreator	1
PlayerCreator	1
Building_VOGD_M_BUILDING_AMHOTTEN_...	1

DEMONSTRATOR - DYNAMIC DESTRUCTION



Application topology

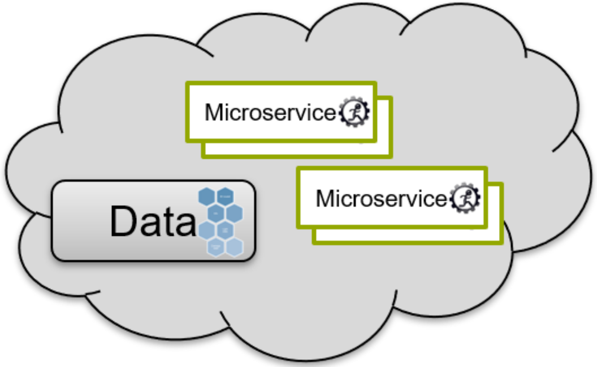


Network topology

DEMONSTRATOR: DESTRUCTIBLE TERRAIN

- Data model
  - Now: used ad-hoc schema
  - Todo: use concepts from the RPR-FOM

- Microservices:
  - ArtilleryFireService
  - Munition creator (artillery)
  - Munition detonation handler
  - Detonation effect handler
  - Damage assessment (physics-based destruction)
  - Damage assessment (model switching)
  - Entity movement (simple motion model)
  - Player movement (stealth viewer)



DEMONSTRATOR - LEASONS LEARNED

- SpatialOS
  - Steep learning curve
  - Beta (regular version updates that break the API)
  - Game focus
    - e.g. data read/write permissions (security / anti-cheat)
    - performance
    - User-based access
    - …
  - Still need prediction (Dead Reckoning/ interpolation)
  - Easy to create gateway to integrate existing HLA applications
  - Hosting (public cloud, enterprise cloud)
  - Not an open architecture
  - Licensing

NEXT-GEN ARCHITECTURE USING MICROSERVICES

Advantages:

1. Centralized approach to ensure data correlation and *fair play*
2. Interoperability via a data model
3. Scalability / off-load computational work to the cloud (overcome limitations of local client)
4. Separation of concerns (experts work on specialized microservices)
5. (Visual) representation generated by client (Stealth view, Dismounted view, Flightsim, C2 view, …)
6. Multi-resolution (different microservices, data abstraction, …)
7. Centralized configuration, management and monitoring

NEXT-GEN ARCHITECTURE USING MICROSERVICES

Concerns:

- Microservice interoperability - Data model (components) needs to be standardized for reuse

- Microservice interoperability - Need for clear description of functionality and behavior (app store)

- Timing issues (risk of asynchronous updates)

- How to scope a microservice (granularity)
    - 100 Lines of Code? 1000 Lines of Code?
    - Single concern, testable behavior

DISCUSSION

- For our dynamic SE use case, promising architecture:
  - Centralized data model allows for dynamic terrain correlation
  - Performance and scalability of platform allows for complex dynamic effects (building destruction)
- Is this the next-generation simulation architecture implementing the MSaaS vision?
- To make this work in practice:
  - Standardize microservice interoperability (data model, API)
  - Support transition phase and legacy systems
  - M&S system vendor business model has to change

THANK YOU FOR YOUR ATTENTION