
"Connected"
Visual Computing
Context
Awareness
Bridging
the Real World
with the Digital
Sensing
ID: boll weevil
Non-Linear Presentations
Live Cam

Intel's Connected Visual Computing Research

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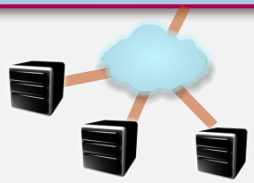
Agenda

- Introduction to CVC
- The Requirements of CVC
- Intel's CVC Research Agenda
- Summary and Q&A

Internet Trends

Social Networking

User-generated Content



Broadband Connectivity

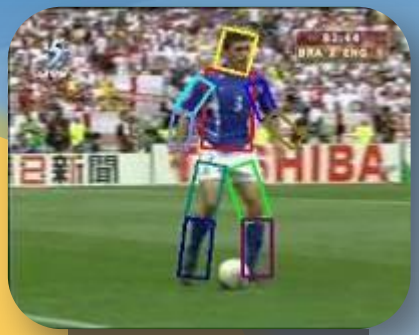
Mobile Computing

Visual Computing

Visual Computing – 3D and more

Ray-traced Graphics

Look real
Act real
Feel real



Video Search

Expressive Faces

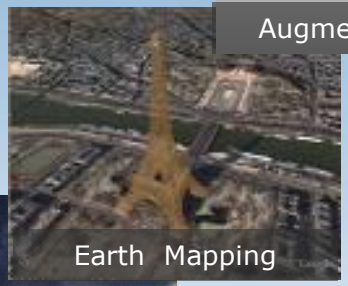
Physics-based Animation

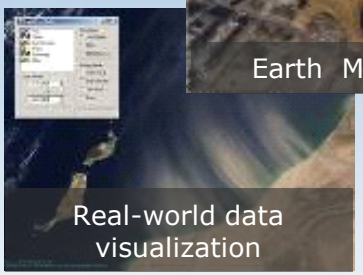
Computer Vision

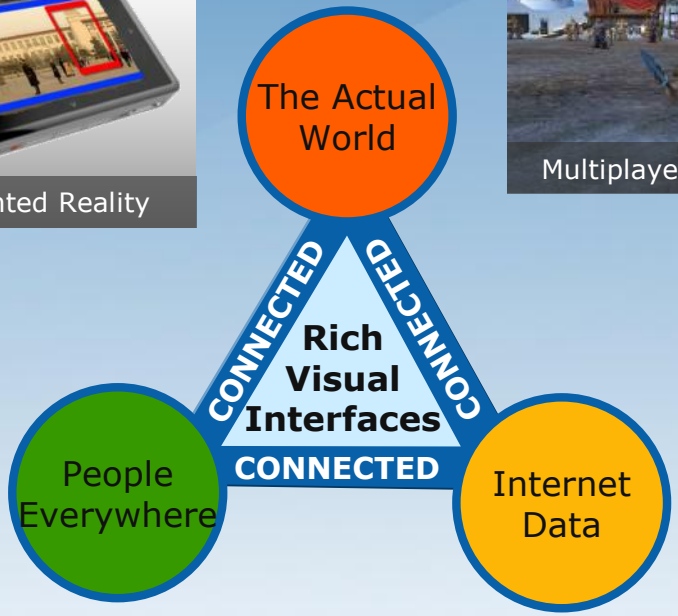
Next: *Connected* Visual Computing

*Bringing the richness of VC to **connected** usage models such as social networking, collaboration, online gaming, & online retail.*

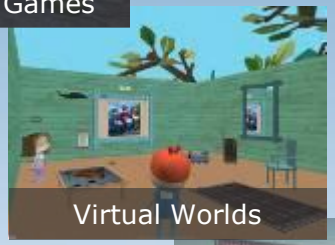
Enhancing the actual world







Creating new digital worlds



LIMITED ← Static Web → Web 2.0 → **CVC** → RICH

Better content quality, social interaction

Virtual Worlds Growing

Habo

90M

Neopets

45M

IMVU

20M

Second Life

14M

BarbieGirls

13M

Webkinz

5M

#of registered users (M); KZERO 6/08

- *Users in May 2007:* ***60M***
- *Users in June 2008:* ***303M***
- *Expected in 10yrs:* ***1 Billion***

Virtual Worlds Facts:

- >$1B invested in 2007
- Over 2,000 VWs today
- VW's merging w/ popular social networks
- >50% of users today are kids aged 4-12

Sources: eMarketer*, KZERO, Virtual Worlds Management, comscore*, TIA, NPD, Intel estimates

Augmented Reality Evolving

- Combines real world information with data overlays.

Location Information

Identification & Hyperlinking

Virtual Instruction

Translation

- *Mobile* Augmented Reality (MAR) particularly compelling

Today	*2010*	*2012*	*2014*
Map Hybrids	*Visual Search*	*Text Overlays*	*2D/3D Visual Overlays*

Introduction to CVC

A compelling set of *connected* visual computing usage models are growing rapidly in the market

Next: The Requirements of CVC

Meeting the Challenges of CVC

Platform Optimization

- Server, client demands
- Network performance

Distributed Computing

- Scaling
- Client diversity

Visual Content

- Interoperability
- User creation

Mobile Experience

- Better connectivity, BW
- Sensor integration

Platform Performance Demands

SERVERS: 10x More Work

75%+ Time = Compute Intensive Work

TYPE	SOFTWARE	MAX CLIENTS PER SERVER
MMORPGS	WoW	2500
VWs	Second Life	160

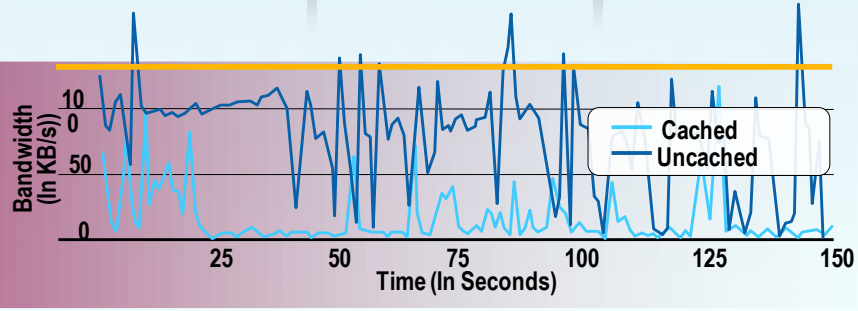
CLIENTS: 3x CPU, 20x GPU

65%+ Time = Compute Intensive Work

APPLICATION	% CPU UTILIZATION	% GPU UTILIZATION
2D Websites	20	0-1
Google Earth	50	10-15
Second Life	70	35-75

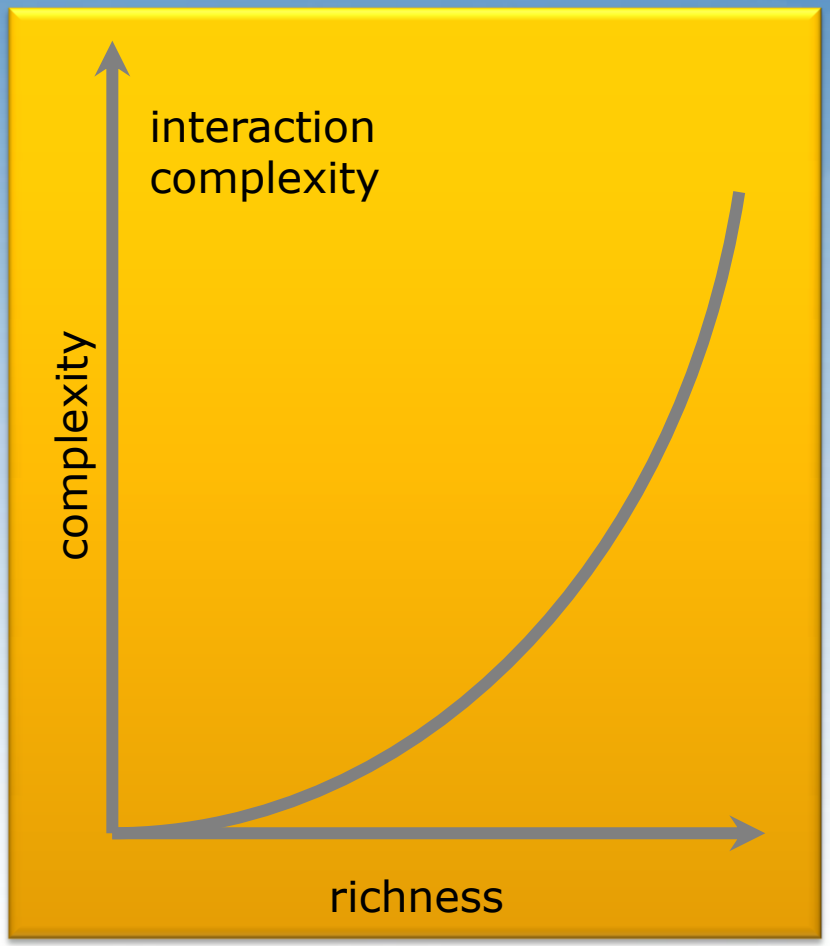
NETWORK: 100x Bandwidth

Maximum Bandwidth Limited by Server to Client



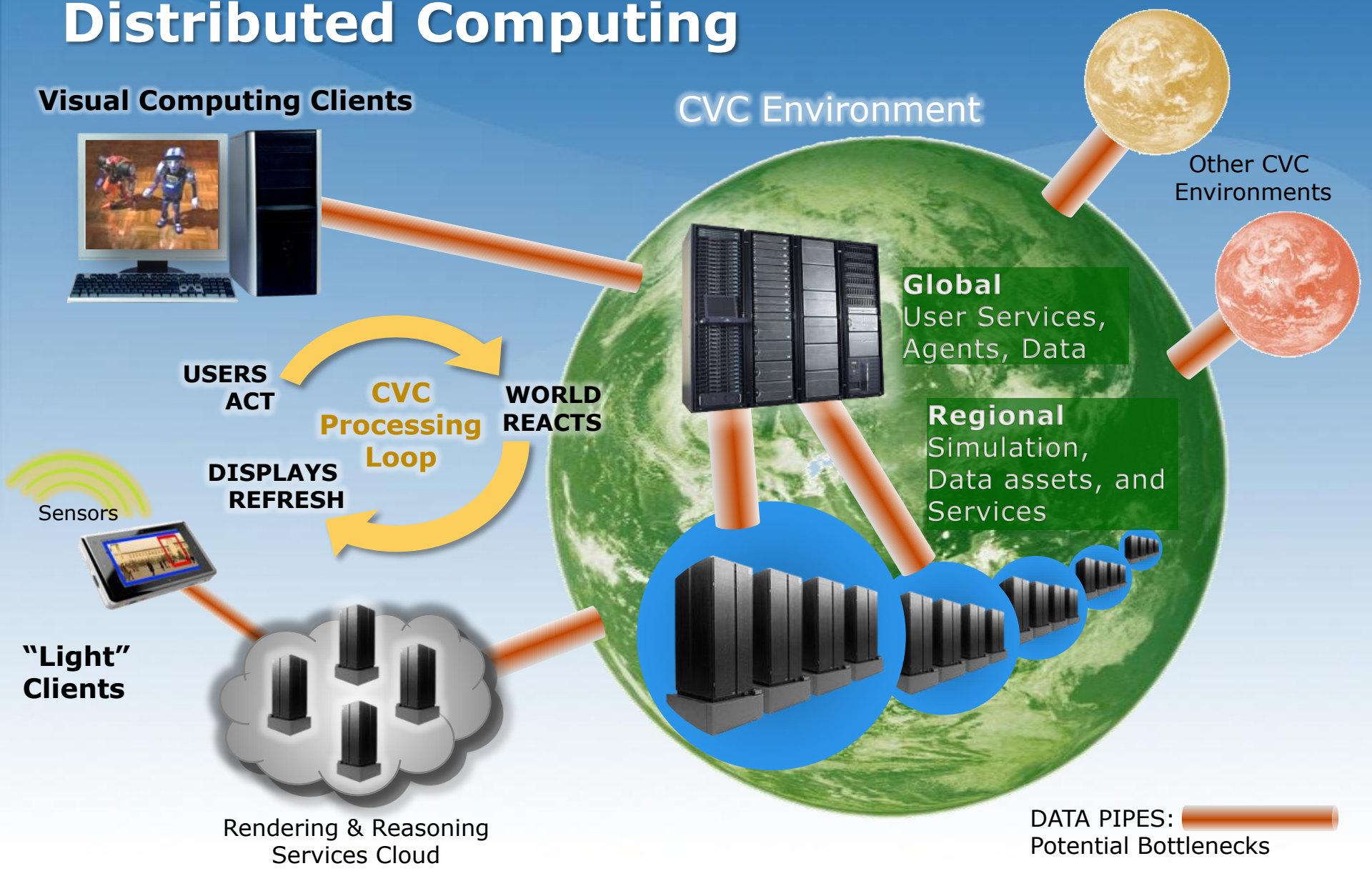
Sources: WoW data (source www.warcraftrealms.com), Second Life data (source CTO-CTO meeting and www.secondlife.com), and Intel measurements.

Rich Interaction vs. Complexity



- Interactions
  - Growing # of users
- Scene complexity
  - Growing # of objects
- Realism
  - Better object behavior

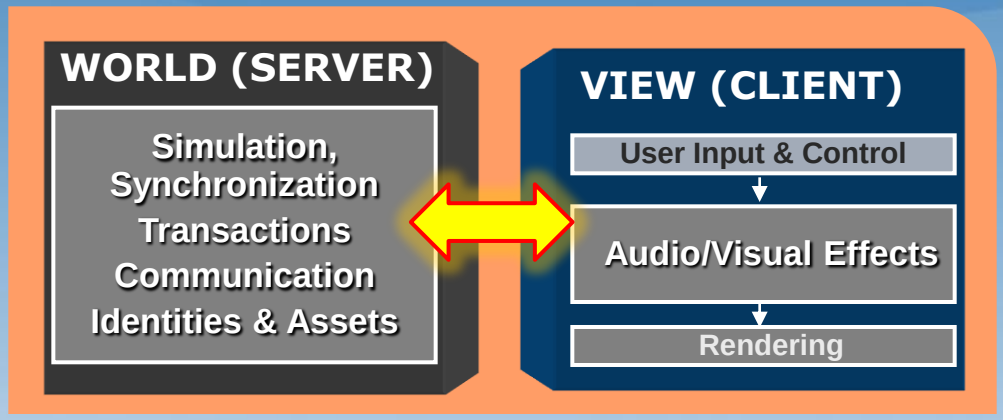
Distributed Computing



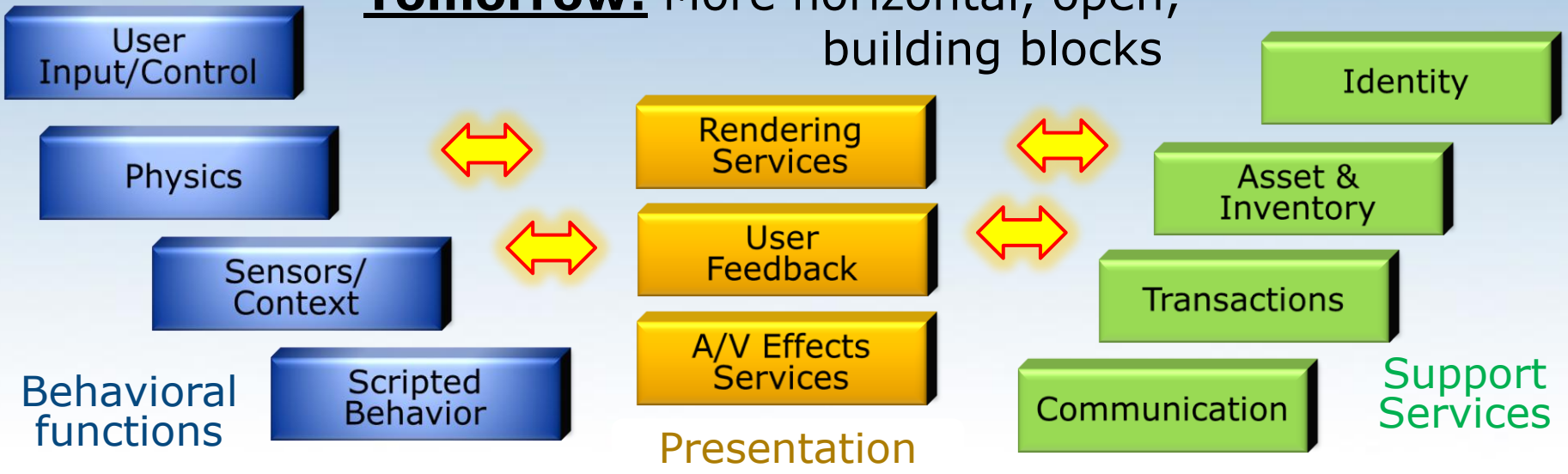
From Monolithic to Building Blocks

Today:

Vertical proprietary, CVC apps



Tomorrow: More horizontal, open, building blocks



Visual Content

- **Easy User-Generation**
  - Professional → End-user
- **Interoperability**
  - Own, share "my" content
- **Scalable Delivery**
  - Pre-distribution →
    Just in time distribution, caching

The Requirements of CVC

Bringing high quality, scalable CVC experiences to the mainstream will require broad innovation

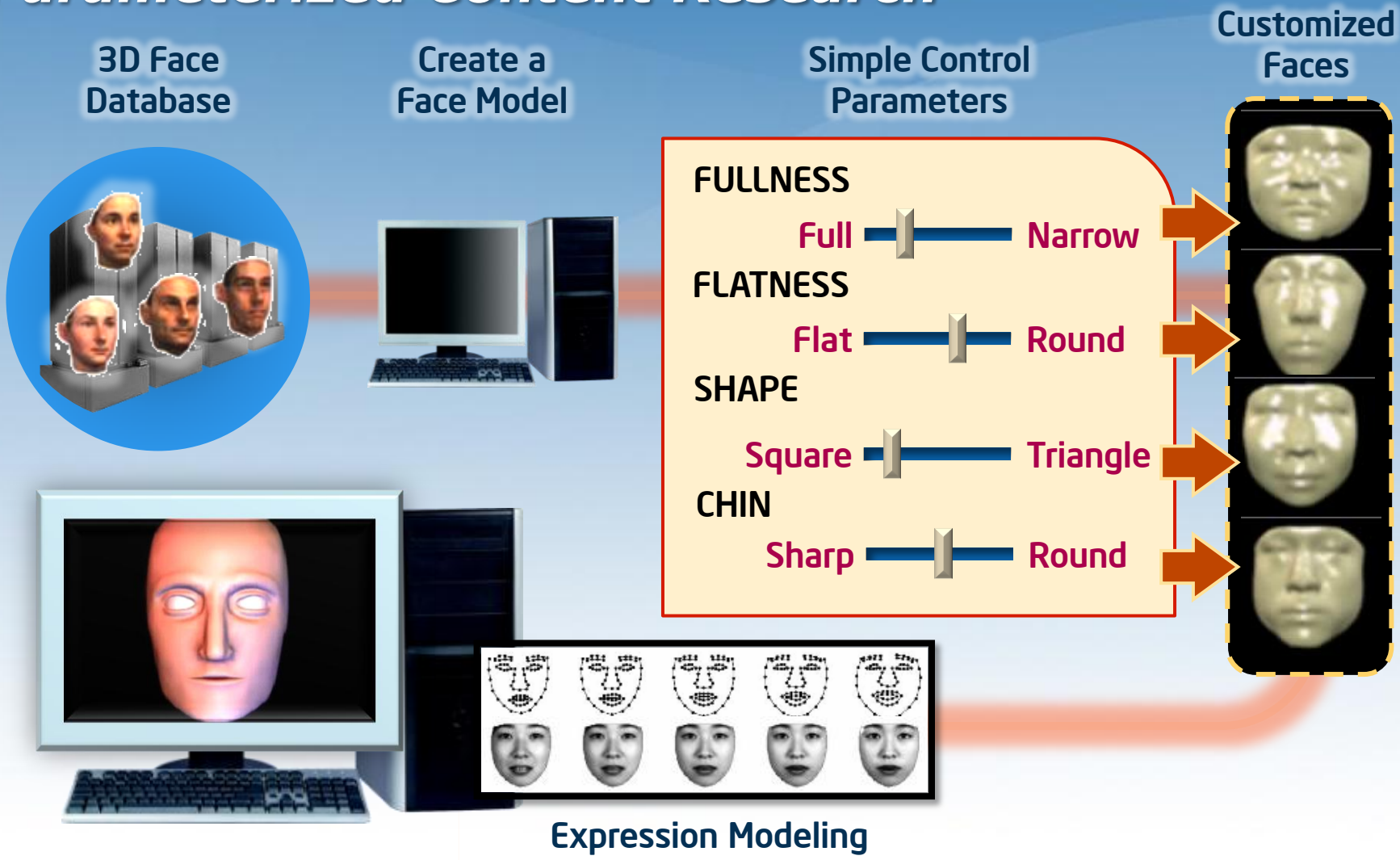
Next: Intel's Research Agenda

Intel's CVC Research Agenda

CHALLENGE	NEW RESEARCH
Platform Optimization	•Workload Characterization •Understanding platform demands •Optimizations for future platforms
Distributed Computation	•Scalable system, app architectures •Dynamic repartitioning of workloads •Execution on diverse clients
Visual Content	•Parameterized Content •Easy User-generated 3D Content •Standards enabling content reuse
Mobile Experience	•Data-enhanced real world interaction •Mirror-world creation and navigation

Simplifying Content Creation

Parameterized Content Research



Improving Mobile Experiences
Synopsis-Based Reasoning

Mobile Augmented Reality

Relevant data, Pre-processed

Feedback

In addition to graphics, image and sensor processing will be distributed to overcome compute limitations

Engaging the CVC Community

Example: OpenSim

- Open platform for creating, deploying 3D environments
- Diverse Dev Community
  - Virtual World Service Providers
  - Intel™, IBM™, Microsoft™,

Working with industry players to explore innovations in distributed system scaling & interoperability

HIGHLY MODULAR ARCHITECTURE

Research Synergy

Our CVC R&D vision will tie together some familiar Intel research initiatives

Tera-scale

Scaling Performance:

80-core Prototype

Ct Programming

Ray Tracing

CVC Research

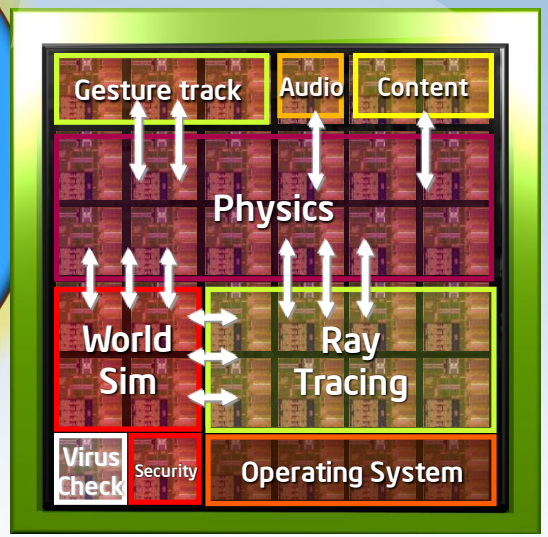
Carry Small Live Large

Redefining Mobility:

More Powerful

More Aware

More Personal



Conceptual Tera-Scale CVC Processor

Intel's CVC Research Agenda

Intel is driving CVC innovation with new and existing research as well as external collaborations

Next: Summary and Q&A

Summary & Q&A

- CVC presents a host of technical challenges
- Intel researchers are driving CVC innovation by:
  - Optimizing platforms
  - Developing better distributed computing architectures
  - Inventing new technology for user-generated content
  - Enhancing the CVC mobile experience
- This research, together with industry and academic collaborations, will help enable a rich new world of experiences and interactions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