

Smartphone Augmented Reality

Context is King

Clark Dodsworth

Product Strategy, Innovation & Development



Process of tool design

Empathic pragmatism

Broad-based tool knowledge / pattern recognition / intuitive

Perspective

“Product as tool as interface”
Tool should adapt to you.

Work

User-centered product strategy, dev,
design.



Projects

AR

VideoCart, '92: *Location-aware mobile retail touch-screen kiosk network with data-driven path mapping.*

“Ambient Intelligence” strategy, '98: *Philips Consumer Electronics.*

Royal Tyrell Museum, Alberta, '06: *Smartphone AR paleontology exhibit complex across 11 remote archaeological sites.*

Dubailand theme park, '08: *hyperpersonalized smartphone AR experience.*

Other Tech

SimEx-Iwerks '93-'07: *Product strategy in high-tech entertainment.*

The Leonardo museum, '07: *Design: pervasive 24/7 social relationships with their public.*

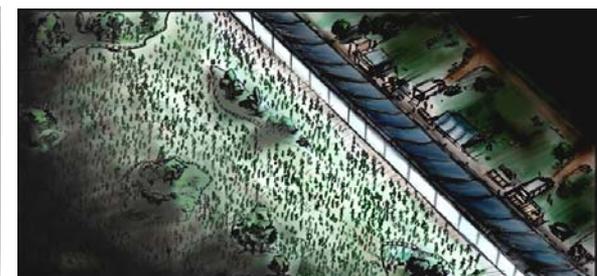
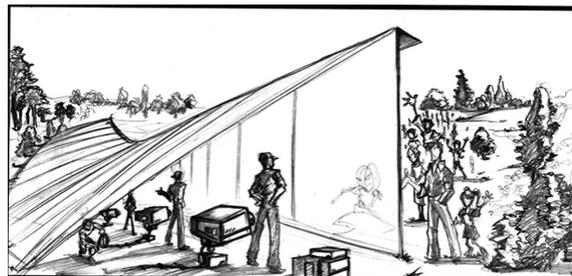
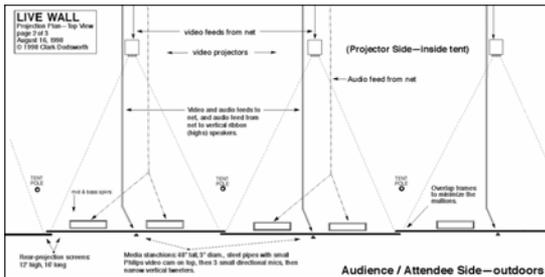


VideoCart: mobile *location-aware* touchscreen retail, '92



Live Wall: videophone design

Philips, '98



“Ambient Intelligence” strategy

Philips, '98

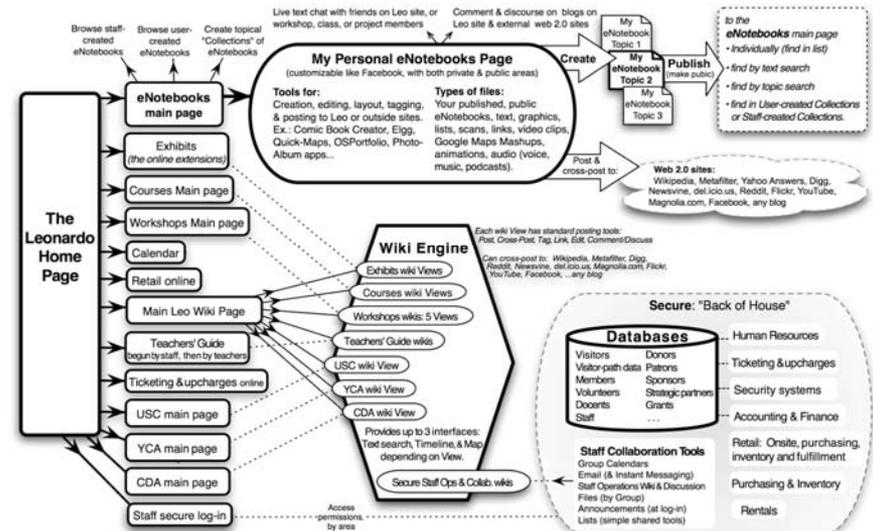


The Leonardo, Salt Lake City '07



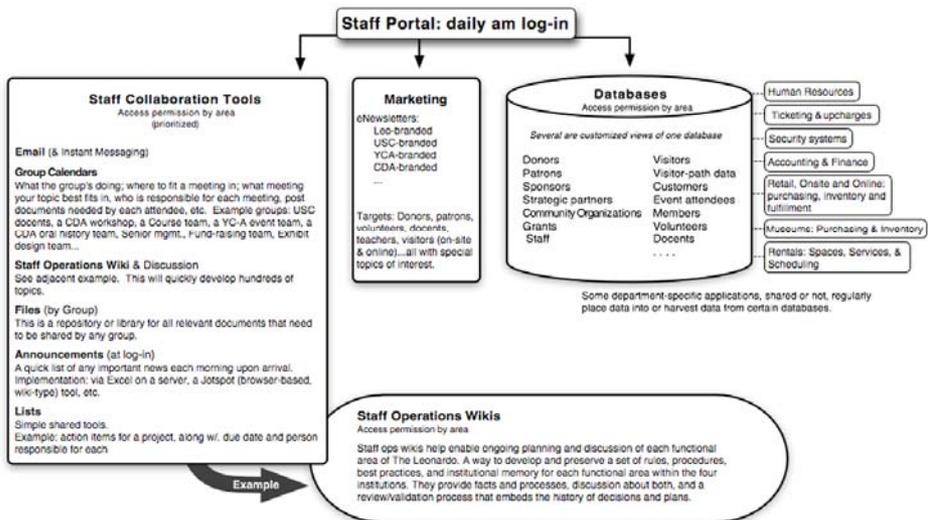
The Leonardo Digital User Experience

Features Diagram v. 5.2 February 1



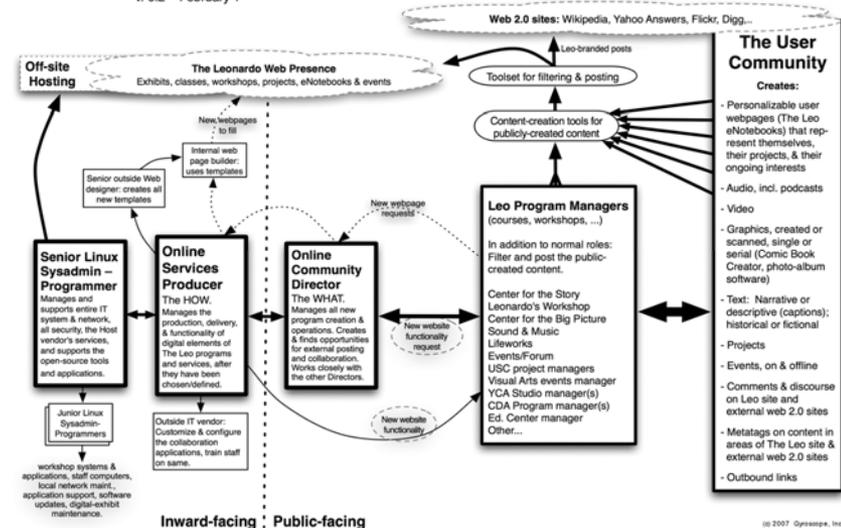
The Leonardo: Staff User Experience

Secure Areas v. 4.4 January 30, 2007



The Leonardo Digital Program Operations

v. 6.2 February 1



Alfred North Whitehead (1861-1947)

Mathematician, philosopher & first augmented reality theorist

#1: “Civilization advances by extending the number of important operations which we can perform without thinking of them.”

...AR shouldn't increase cognitive load

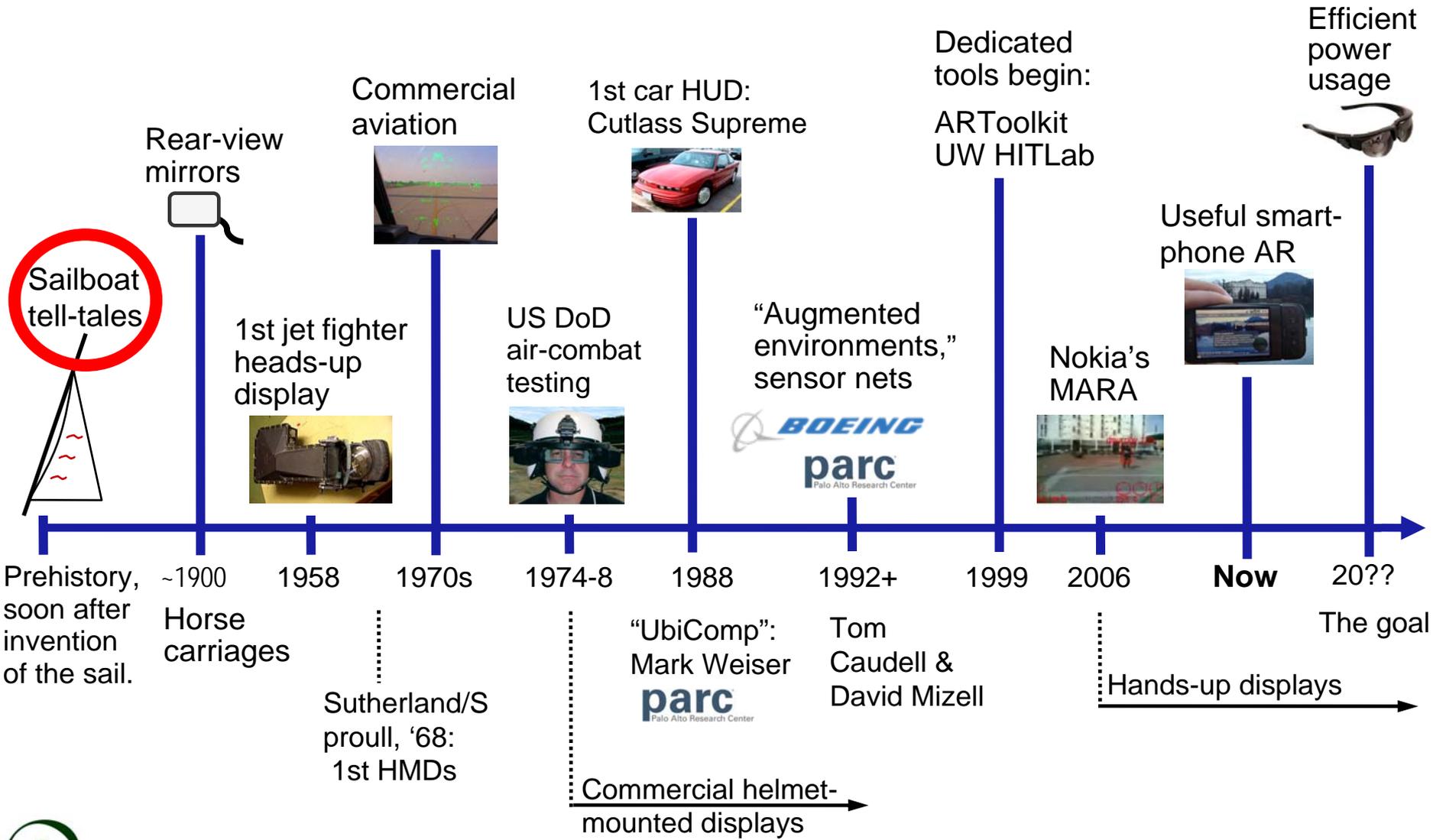
#2: “The art of progress is to preserve order amid change and to preserve change amid order.” *...AR: contextually dynamic data management & display*

#3: We think in generalities, but we live in detail.”

...AR tasks: managing detail

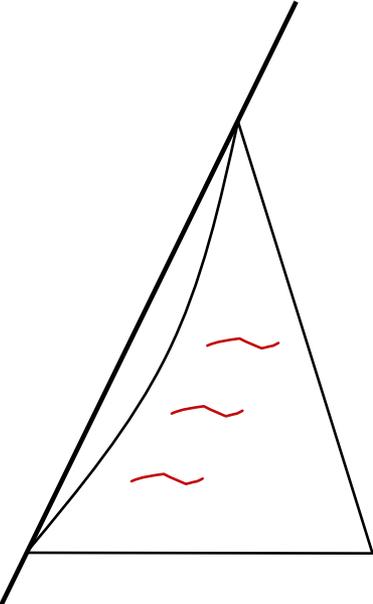


History: AR Timeline



Reed sails on boats in the prehistoric Middle East had inherent sail-edge tell-tales.

Sensor/display fusion

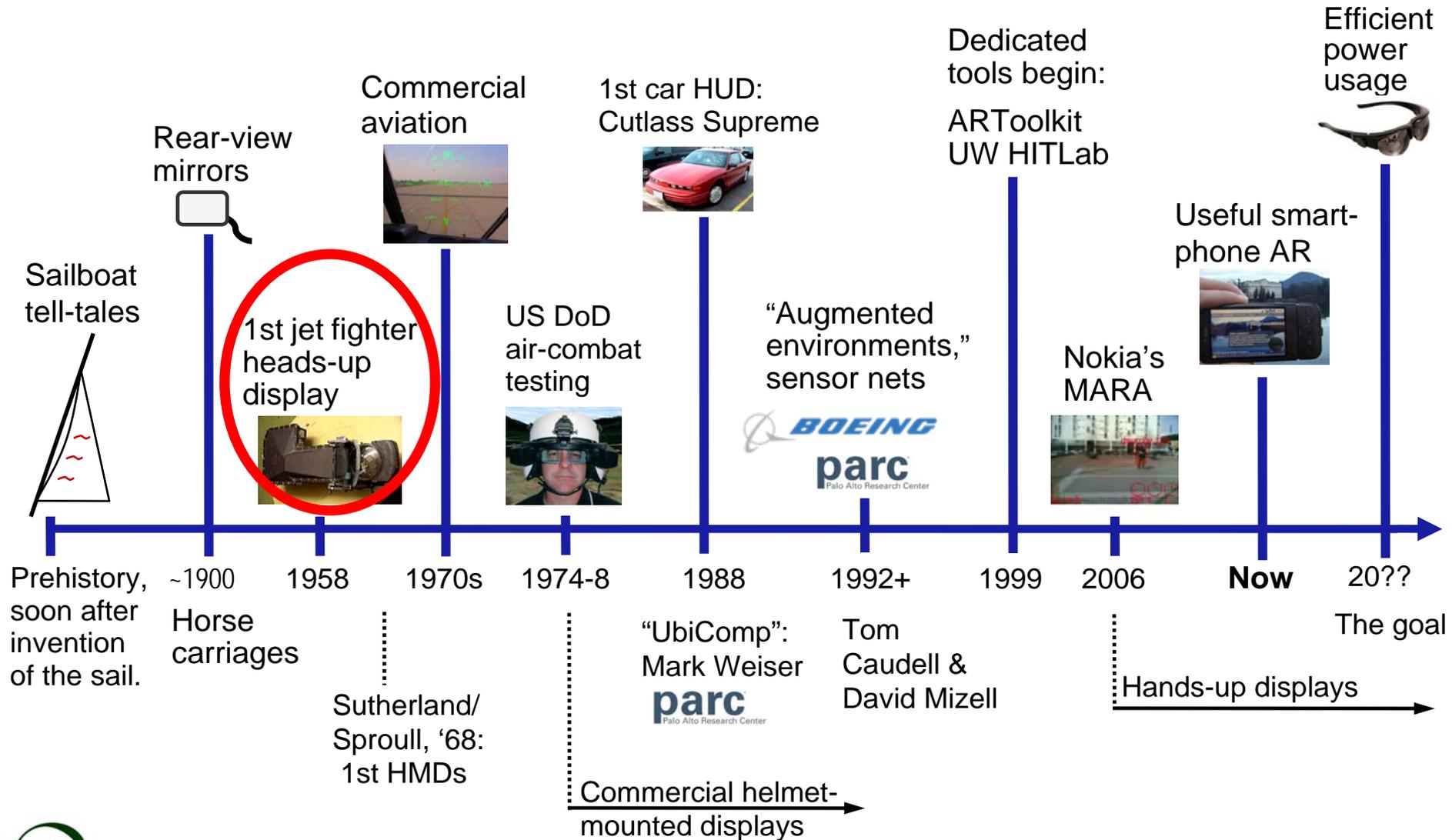


Marmon Wasp racecar, 1911

Heads-Up Display:
Rear view mirror
just above sight line.



History: AR Timeline



Heads-Up Displays (early)

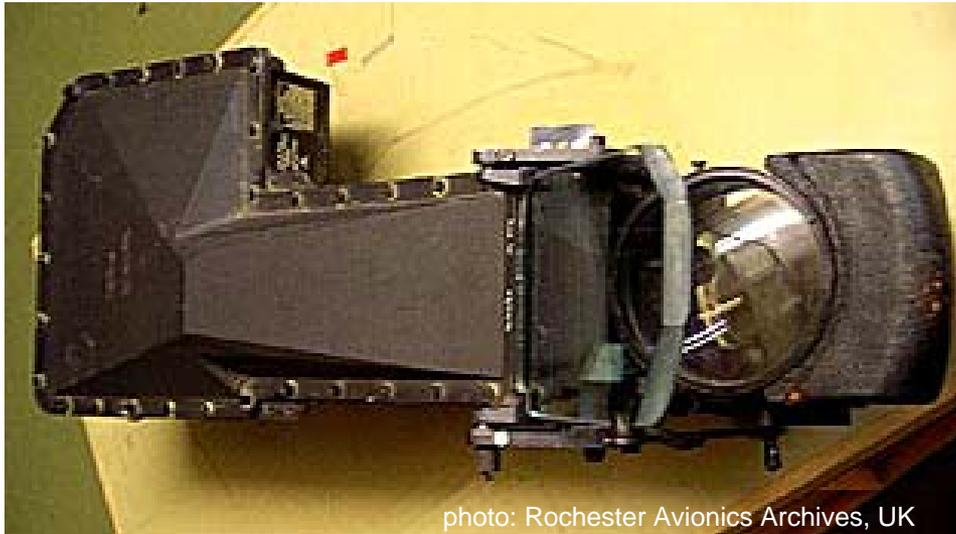


photo: Rochester Avionics Archives, UK

Cintel "Buccaneer"
cockpit heads-up display
device, UK 1958



MIG21 heads-up display
(installed): circa 1960s

photo: Will Hise cc

Heads-Up Display: modern commercial aviation AR



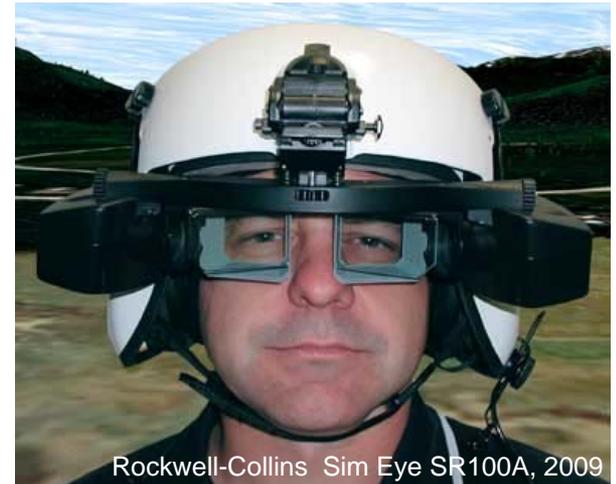
HMDs

Helmet-mounted displays

- High-priority military R&D \$
- Single-function, effective for task
- Tethered to power & CPU
- Partially obstructs field of view
- Delicate to maintain
- Size / weight unacceptable to civilians
- Adds situational complexity
- State of the art = net *loss* of context awareness



Not general AR



HUDs

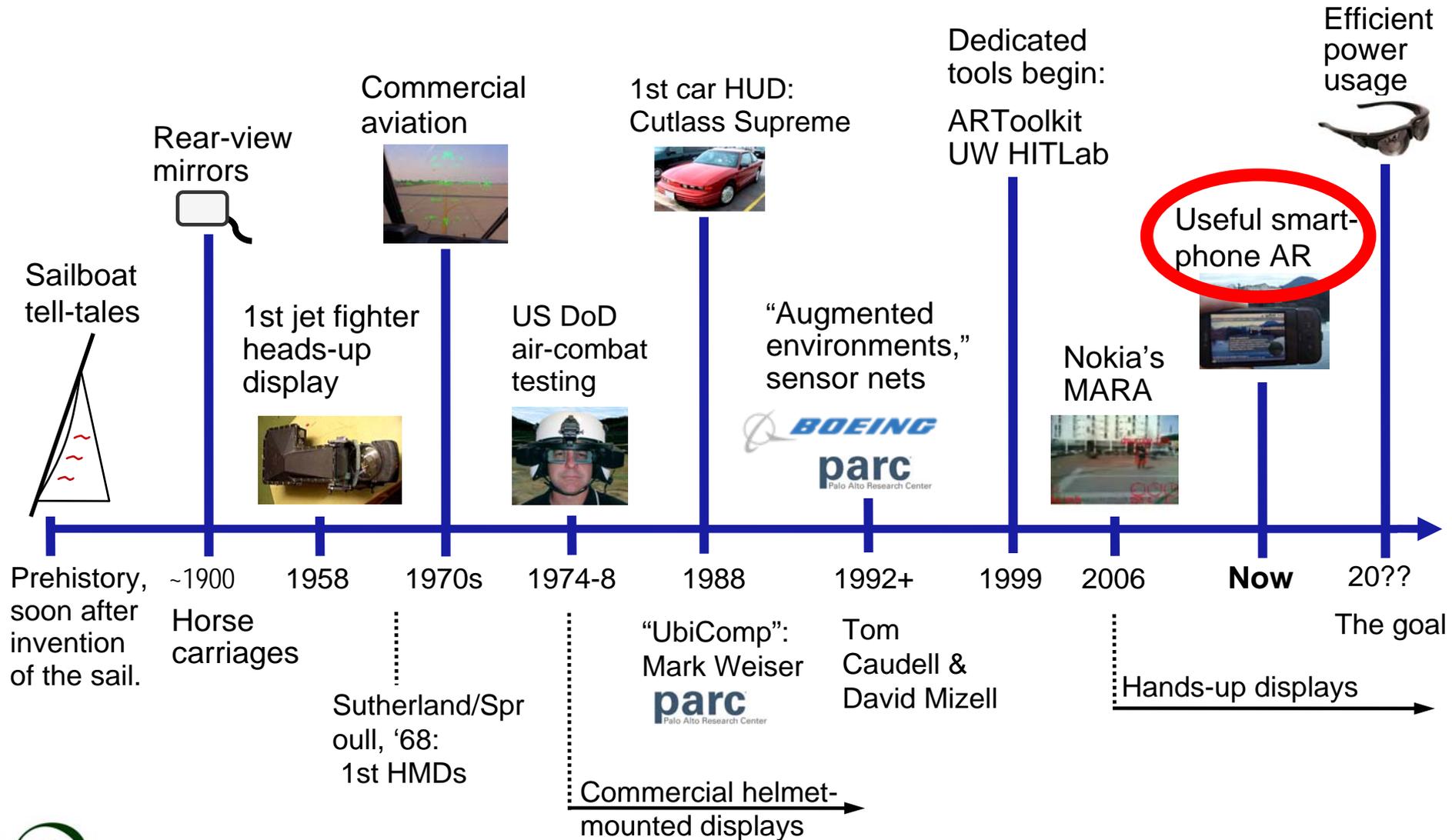
Heads-up displays

First car: Oldsmobile 1988 Cutlass Supreme International
Speedometer projected on windshield.

Modern BMW E60
HUD display
(orange), 2008



History: AR Timeline



Current AR Scope

AR = Well understood in defense industries, vehicle design, games.

AR = Subset of Ubiquitous Computing:
Same infrastructure issues, even more privacy issues.

AR = *When queried* delivery of information.

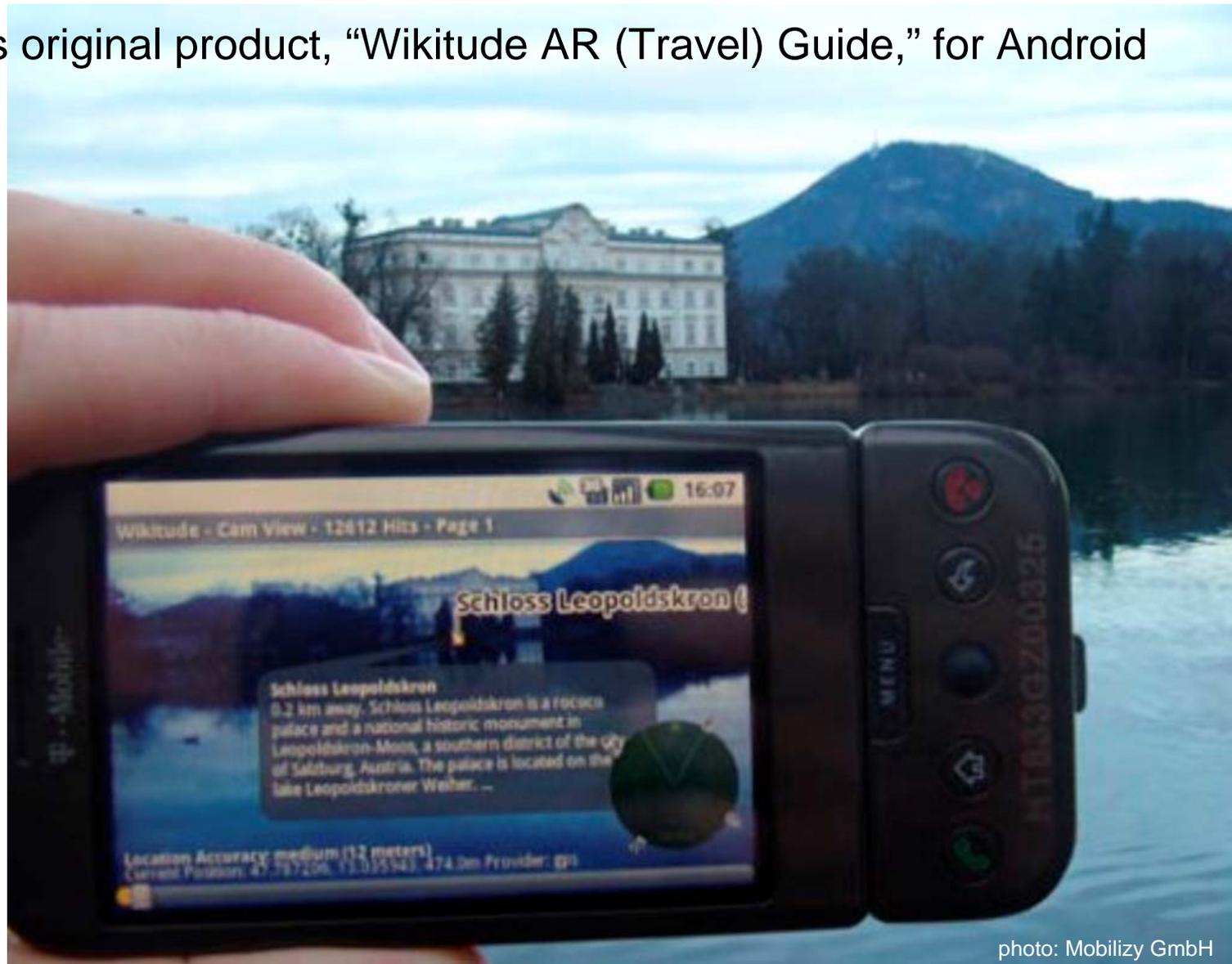
WHERE WE ARE NOW

Not enough utility, personalization, interoperability.



“Hands-Up Displays”

Mobilizy's original product, “Wikitude AR (Travel) Guide,” for Android



Smartphone AR/Phase One activity indicators

Ubiquitous mobile broadband transition:

Texas Instruments (Feb. '10) introduced a **4-radio chip** that delivers wireless LAN 802.11n, GPS, Bluetooth and FM transmit & receive.



Smartphone AR/Phase One activity indicators

Ubiquitous mobile broadband transition:

- Cisco (Feb. '10): “Wireless-data traffic expected to double every year through 2014. 400 million consumers will access the Internet through a mobile connection only.”
- Cisco (Oct. '09) bought Starent Networks (\$2.9B), for wireless carriers to deliver multimedia features. Smartphones generate more than 30 x the traffic of basic cell phones.

...Wait till they see the numbers for iPad.



Smartphone AR/Phase One, recent projections

- **Juniper Research (UK)**

Nov. '09: "By 2014, revenue from Augmented reality downloads, advertising, subscriptions, events, and content increments will reach \$732M."

- **Gartner**

Dec. '09: "By 2013, mobile phones will replace PCs as the most common device for Web access."

- **Gartner**

Dec. '09: "By 2015, context will be as influential to mobile consumer services and relationships as search engines are to the Web.

Context will center on observing patterns, particularly location, presence and social interactions."

- **ABI Research**

Oct. '09: "[Smartphone AR] revenue is poised to grow to \$350M in 2014."



Smartphone AR/Phase One: General

AR + LBS* = features, not an industry.

Will be incorporated into OS.

Requires sophisticated web services & major database backends.

Vertical markets appropriate now.

Lack of standards (OS, platforms, & apps) limits horizontal markets.

Impending acronym fusion:

AR + LBS* + GIS + RFID + IR + etc. = the new POTS** = “my computer”

*Location-Based Services

** Plain Old Telephone Service



Smartphone AR/Phase One

Hardware and Software

- GPS (slow, low-resolution)
- Layering of graphics
- Geotagging photos, > spatial DB search
- Accelerometers for gesture recognition
- Light sensors
- Proximity sensors, usually infrared
- Compass, low res.
- Touch (2D)
- Bluetooth
- 2D target icons, 2D pattern-matching
- Machine vision: object identification



Players

Mobilizy

- Wikitude World Browser & Drive

Nokia

markerless 2D, 3D: Point & Find,
Image Space, MARA

Layar

layered content svcs.: Reality Browser

Studierstube ES

rich dev. framework, 3D object tracking

Siri.com

personalization, voice rec.

Google: "Goggles"

Autodesk

NAVTEQ

The games companies

Sense Networks

Total Immersion (tools): D'Fusion Studio

Metaio (tools): Unifeye Design

Mobile Acuity, Ltd.

visual search: marketing

Tonchidot

Ogmento

markerless feature tracking

Pongr.com

image recognition: mobile retail

Aloqua.com

personalized locational info

Mobile Sorcery

developer services



Platforms and toolkits

Platforms

iPhone 3.2

Android 2.1

Palm WebOS

RIM BlackBerry OS

Symbian S60 5th Edition

Windows Mobile 7

Samsung Bada OS

Mac & PC

PlayStation 3 (EyePet)

Tools

Studierstube ES

Layar

Unifeye Design

D'Fusion Studio

ARToolkit

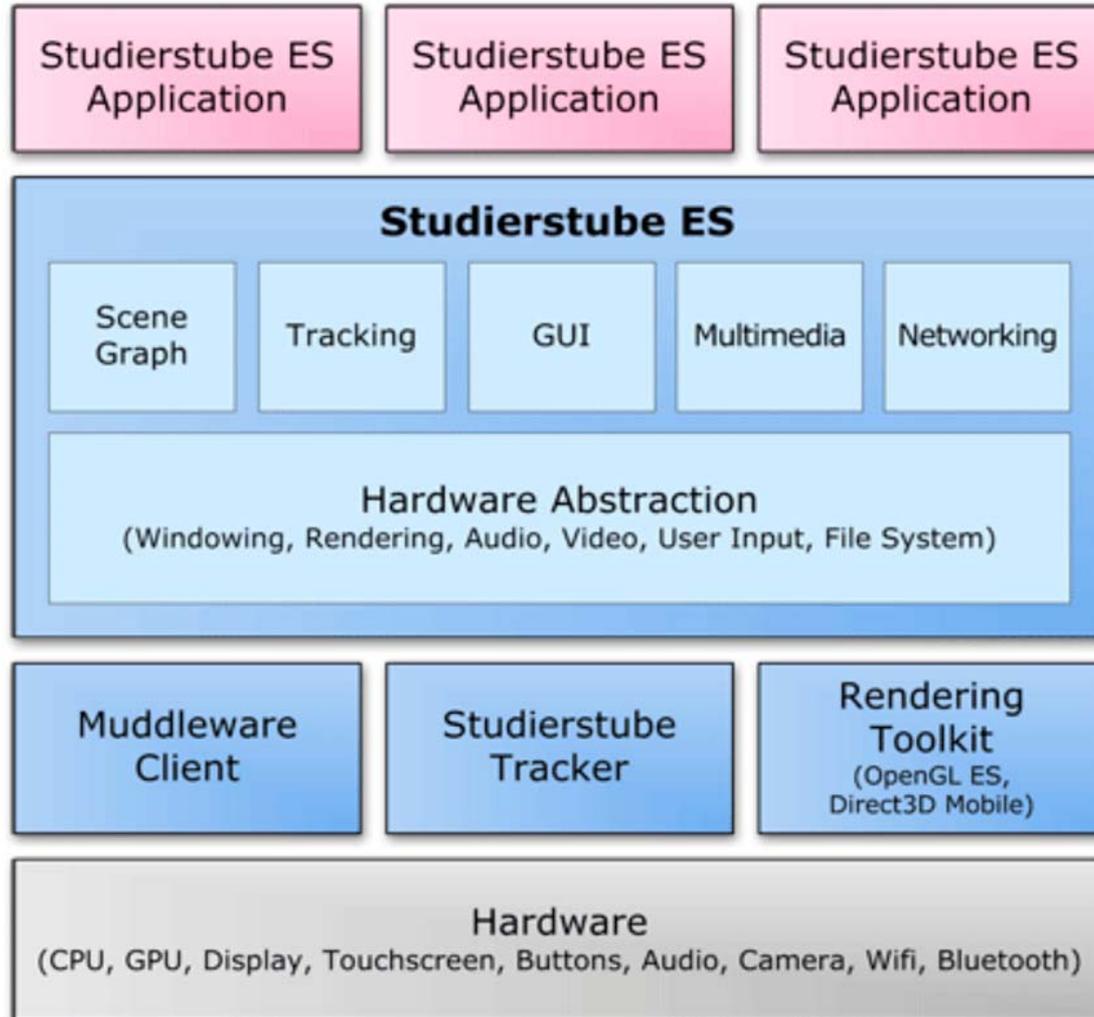
NYARToolkit

FLARToolkit

Tinmith



Studierstube ES toolkit



Phase One achieved

Part of **smartphone** ecosystem.

Hardware & software **platforms** exist.

Infrastructure issues: huge.

Power use issues: huge.

Privacy/security issues: huge.

Interoperability issues: typical.

But

Phase One AR is just one aspect of transition to **mobile broadband devices as our primary platform.**



Augmenting Revenue Now

Immediate value

- Extend existing software to **enterprise mobile, task-assistive** apps
- Build AR into new apps, including web services/DBs
- Extend social networking apps & online worlds/entertainment
- Handheld to desktop screen to projector
- Major brands: marketing extensions



Augmenting Revenue Now

Enterprise mobile applications: Marybeth Back, FX Palo Alto Labs & TCHO

FX(PAL AR Viewer (Factory Application)

Error Report #23
Change parts due to friction
Reporter: C
Date: 2008/XX/XX

Error Report #26
Crack is found
Reporter: D
Date: 2008/XX/XX

Design Change #12
Change length to 340mm
Reporter: B
Date: 2008/XX/XX

Design Change #15
Change position 3mm above
Reporter: A
Date: 2008/XX/XX

Practical Application

- Maintenance or design history with image and text
- Marker-based or image-based AR
- Viewable on tablet or cellphone



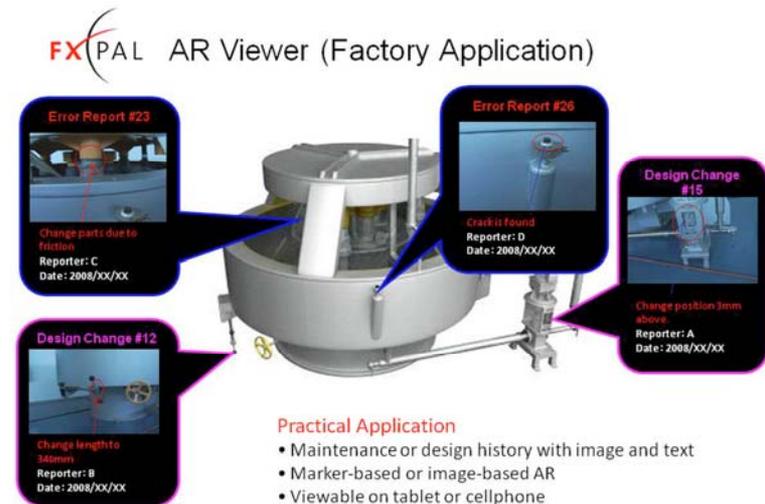
Augmenting Revenue Now

Enterprise mobile applications: Marybeth Back, FX Palo Alto Labs & TCHO

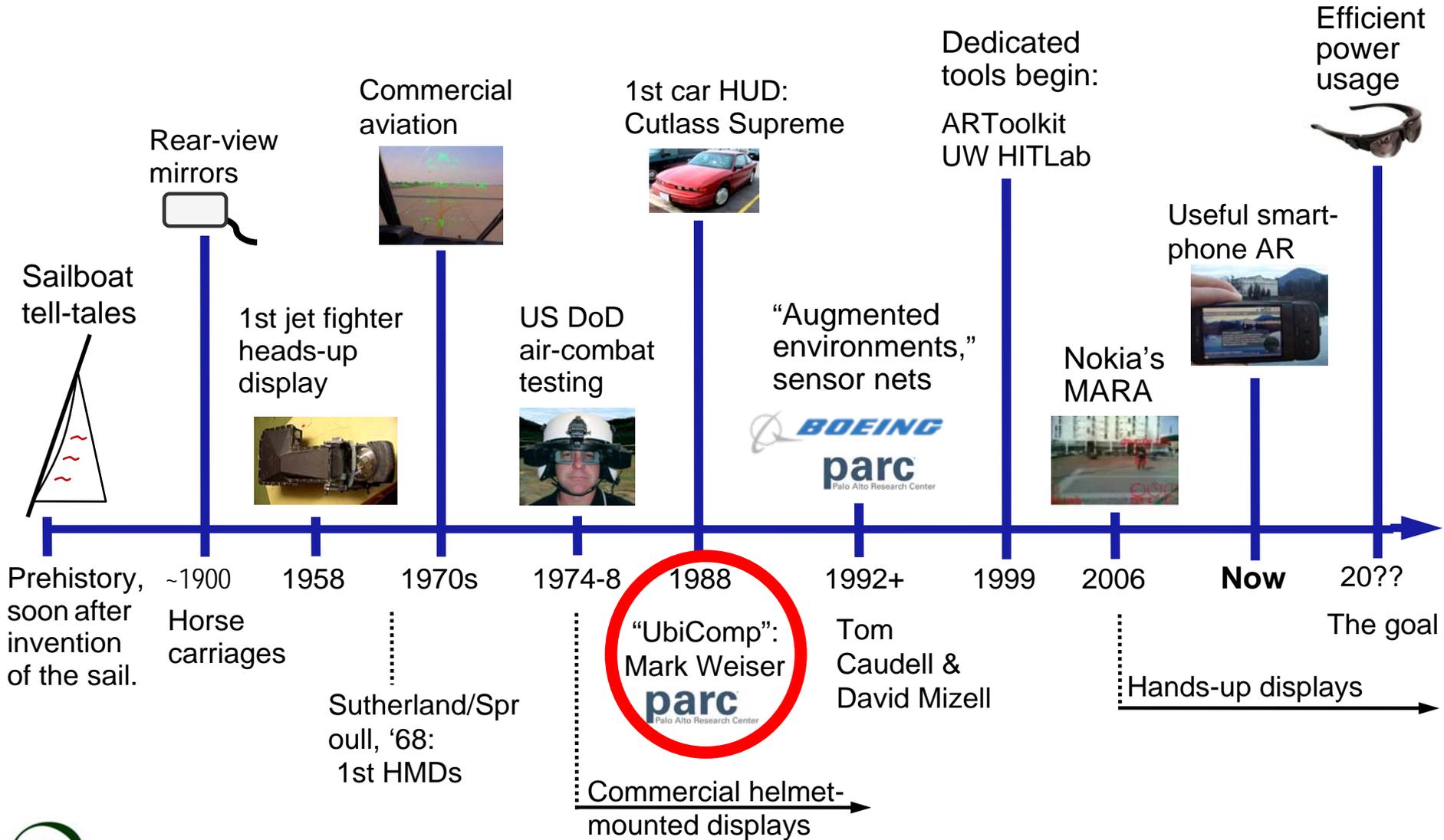
Factory floor AR

Point at specific areas/machines:

- Realtime data from factory control software
 - sensor states
 - control states
 - time-to-service
- Customer & job data
- Actual machine control
- Static info
 - operation procedures
 - maintenance history
 - performance charts
 - overview data
 - unit specifications



History: AR Timeline



Mark Weiser (1952-1999)

Mathematician, philosopher & first ubiquitous computing theorist

- 1:** The purpose of a computer is to help you do something else.
- 2:** The best computer is a quiet, invisible servant.
- 3:** The more you can do by intuition the smarter you are; the computer should extend your *unconscious*.



<http://sandbox.parc.com/hypertext/weiser/>



Next Steps: AR Phase Two

“It’s all about long-term, sustaining relationships.”

-Alan Kay (2009), on the computer industry trend toward a service-based model.

- Phase Two delivers value if we have **long-term, sustaining, *contextually dynamic, hyperpersonalized* relationships** between users & info services.
- The available data streams must be far better managed.

...It will just happen first on smartphones.



AR Phase Two

Adaptively deliver info, highly personalized via n dimensions of user states, with high space/time precision, *without* spiking your cognitive load.

Augmented Context + Information Saliency = Value



Smartphone AR Phase Two

Smartphone ecosystem:

The platform for

- Pervasive computing
- Context-awareness
- Semantic Web
- UbiComp & sensor nets
- Ambient Intelligence
- Things that Think

...at last.



Smartphone AR Phase Two

Mobility

- Diversity of use cases per user.
- User attention: scarce resource.
⇒ *Tool should learn the user.*

The learning is contextual: *context becomes king.*

- Location + user's path in space, time, tasks, people...
- Accretes
- Becomes predictive, scenario-driven.

Result: Adaptive context analysis manages data delivery:
what, when, how much, what priority.

⇒ Especially when **not** to.



Phase Two

Context Is King

Trend to realtime, context-driven mobile broadband services.

“The software layer that learns you.”

Facets:

- Realtime data delivery (live monitoring of processes & states).
- Constant predictive analytics, contextual filtering/salience assessment.
- Your path through space, time, task, data, people, & ...
- Semantic Web: better, more meaningful, partly automated search.
- Hyperpersonalized database creation, web services.
- Sense Networks (NYC)
- Digital assistants (Siri.com) learn you over time.
- Entertainment: “The Character Layer” ...a skin over the functions.



Phase Two Software

- Constant, robust markerless 2D & 3D feature I.D. and object recognition (Nokia Point & Find, Google Goggles ...).
- Motion analysis + evaluation linked to the object recognition.
- General-purpose indoor position mapping: multiple methods.
- More nuanced gestural interpretation + integration with voice.
- Constant audio + visual awareness with flagging & interpretation.
- Allostatic control of data *delivery*: only the data needed, when needed.
- Constant autodiscovery of data & sensor feeds.



Phase Two Hardware

- Near-field RFID (“touch / wand”)
- Constant, wide-field visual recording + auto-tagging
- Constant markerless object I.D. in 2D & 3D + auto-tagging
- Constant audio recording + auto-tagging
- Galileo-grade location (+ dead reckoning extrapolation)
- Ultrasonic & IR sensors for position sensing, spatial analysis, modeling, mapping, contextualizing
- Laser projector + 3D object geometry awareness: “shape-adaptive projection” for **object augmentation**



Phase Two Revenue Example

Entertainment

All major licensed characters available on your smartphone as a useful buddy, *running as the delivery method on top of context-aware, locational, hyperpersonalized functions.*

The character behavior, persona, and actual animation:
Character Skin or **Character Layer.**

An opportunity-rich scenario.



Dubailand AR project, '07-'08

- Convert the concept to smartphone AR
- Live & scripted personalized entertainment via licensed characters, plus services for hotel, leisure, retail, restaurant, transit, *and* follow visitors home.



© Chimera Design 2007-2008



Dubailand AR project '08



Dubailand AR project '08



- Storytelling
- Extension of attractions
- Personal guide/friend
- Contextually customized experiences
- Interaction with park elements
- Wayfinding
- Drill-down for information
- Social networking: local & global
- Database: each user's interests
- Game play on device & with others
- Marketing: retail opportunities
- Long-Term Relationship:
"follow the visitor home"

Phase Two Revenue Example

Health

N-dimensional context-awareness of states of medical procedures, constant salience assessment of those states, plus data streams from a constantly adjusted subset of the hospital's devices, systems, dispensing & scheduling software, per patient, accreting into realtime patient history, plus staff paths and staff tool usage (also accreting). Constantly perform predictive analytics on the streams of states & data.

- Error Avoidance, detection & correction in routine and acute treatment
- High-trust home care provision systems: reducing hospital bed nights
- Realtime status information delivery, *as needed*, for each staff member
- Escalation parameter modeling and monitoring
- Services deployment derived from Point Of Care Testing
- Dynamic, adaptive resource allocation
- Assistive management of very large datasets for treatment/diagnosis



Phase Two Model - Consciousness

Some key functions of human consciousness:

- 1) Constant, integrated analysis & evaluation of surroundings
- 2) Dynamically judge salience of each aspect of user's current situation in context of personal goals/needs
- 3) Constantly construct scenarios for next step: drives info delivery

~ ~ ~

Parallel function of AR2: assess, select & deliver salient data:

- “Contextual evaluation drives contextual augmentation”
- “Software ‘awareness’ augments user’s awareness”

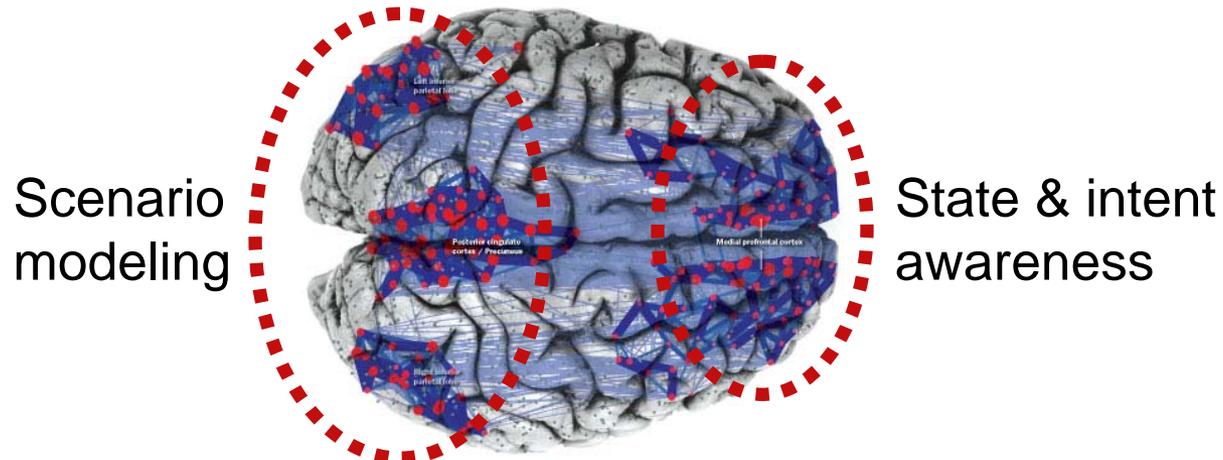
History + current state = basis of **decision-making for next state**



Phase Two Implementation Model

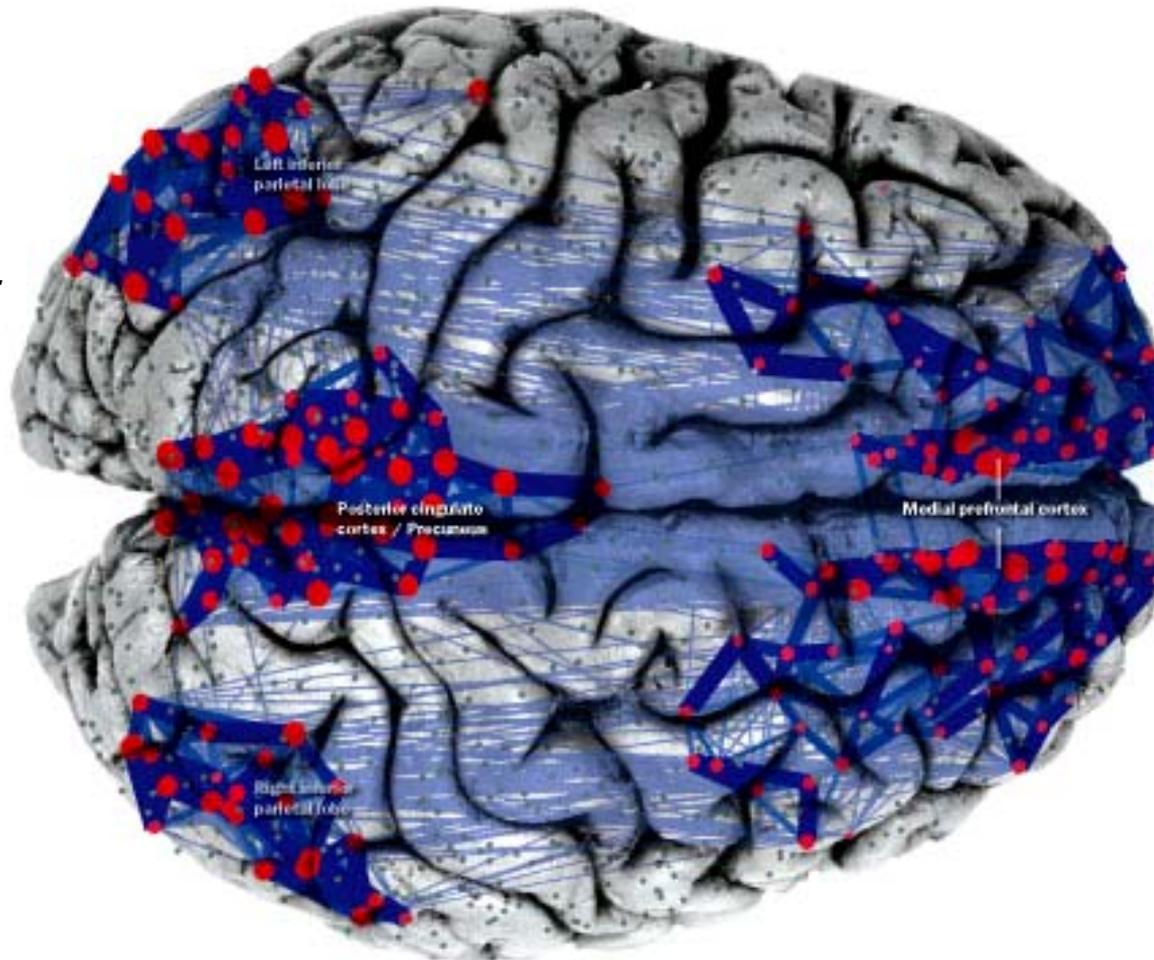
The brain's Default Mode Network

- One of the hardest-working systems in the brain
- Active only when the brain is *not focused* on a particular task
- 2 linked brain areas:
 - A) Imagination, empathy for *intent* of others, + **state** awareness
 - B) Personal *memories* + visualization of future *scenarios*



Default Mode Network of the brain

*Posterior cingulate cortex, with the precuneus: accessing personal **memories**, visualizing oneself in **scenarios***



*Medial prefrontal cortex: **Imagining & modeling the mindset** of others.*

➤ *Who you are, what's relevant now, and very-near-future scenarios to choose from*



Phase Two Implementation Model

Brain Default Mode Network = constantly considers what to do next

- > Observe states/intents, visualize scenarios/outcomes
- > Scenario creation supports each next **decision**

Phase Two mobile broadband apps assess, prioritize, & select data to deliver...to support **decisions**

- Realtime information mgmt. helps **preserve focus**
- Inverse Content Management System (CMS) ...the **filter** part
- Adaptive B2B & B2C service optimization ...the **revenue** part



Phase Two Model - Function

Revenue & efficiency from contextual salience

Location Based Services

Hyper-personalization,
relationship mgmt.

Autodiscovery:
net services &
sensor data

Integrated sensor,
gesture, & voice

Predictive
analytics

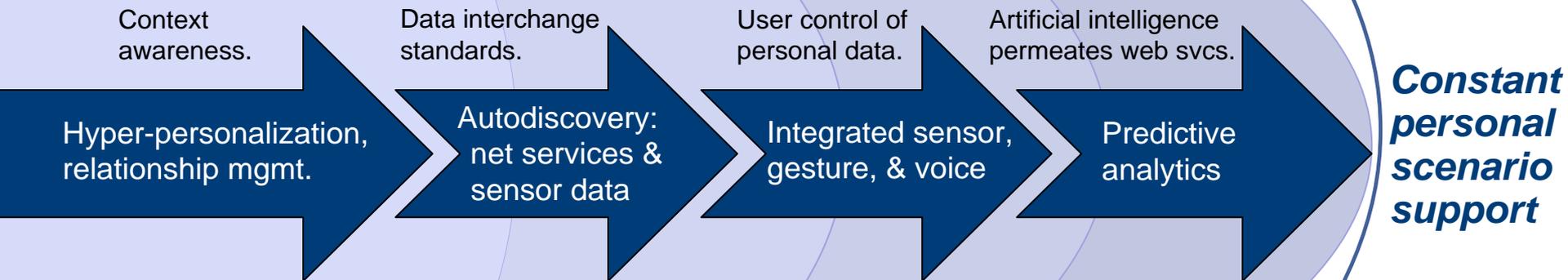
*Constant
personal
scenario
support*



Phase Two Model - Function

Revenue & efficiency from contextual salience

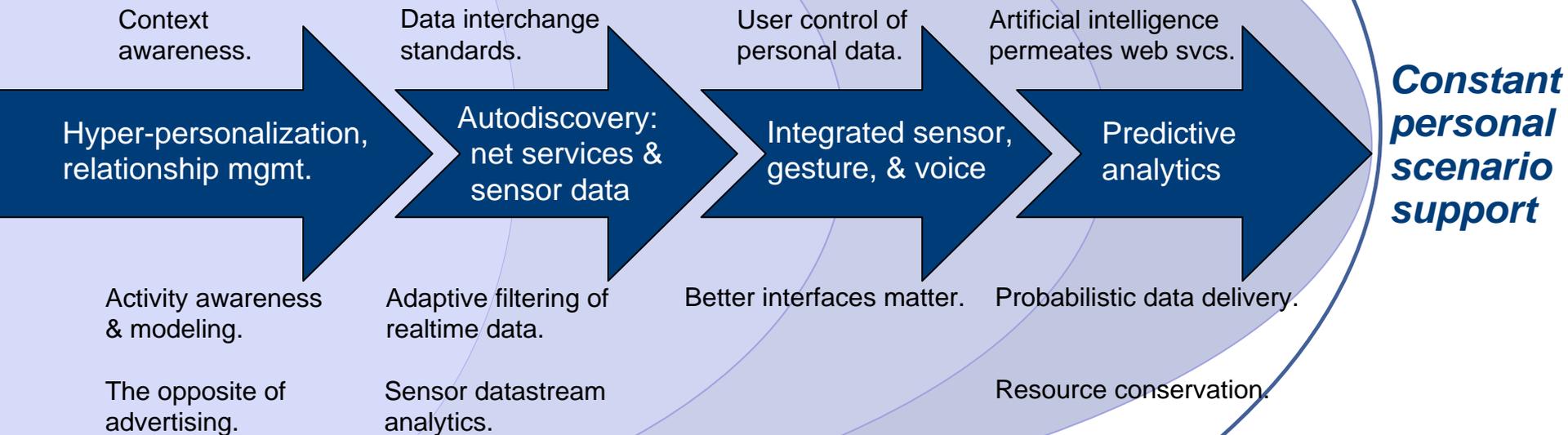
Location Based Services



Phase Two Model - Function

Revenue & efficiency from contextual salience

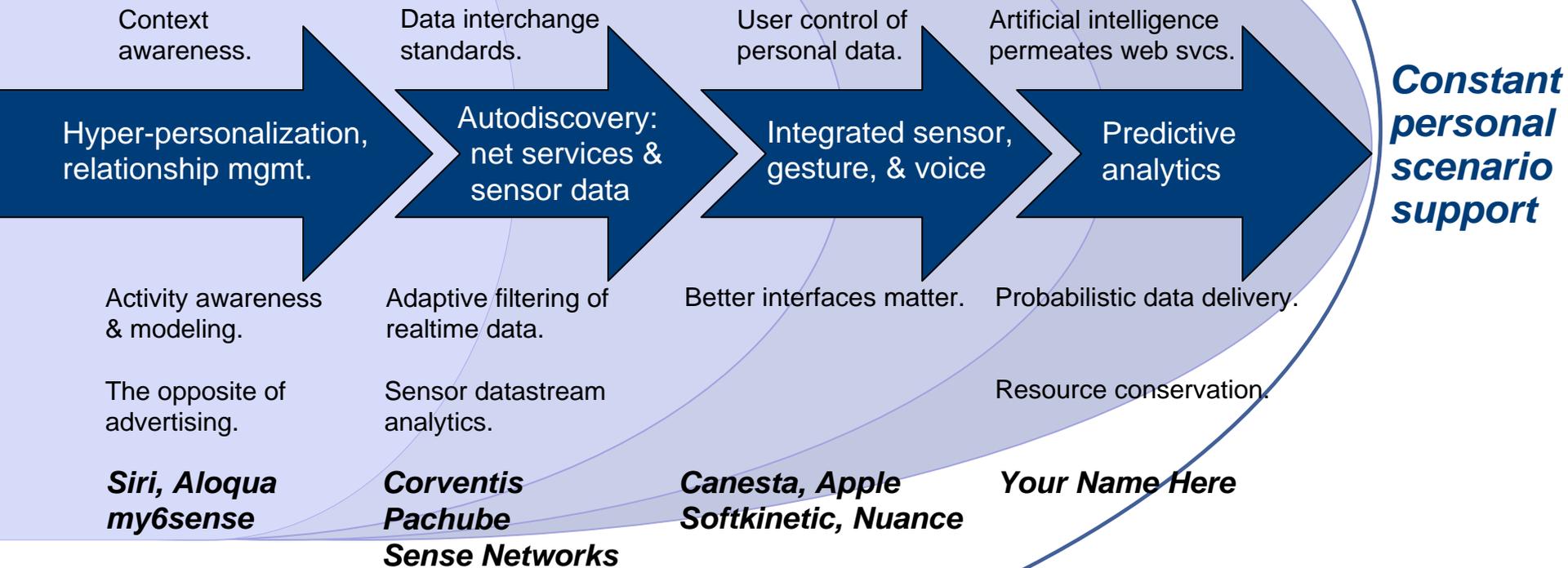
Location Based Services



Phase Two Model - Function

Revenue & efficiency from contextual salience

Location Based Services



Software

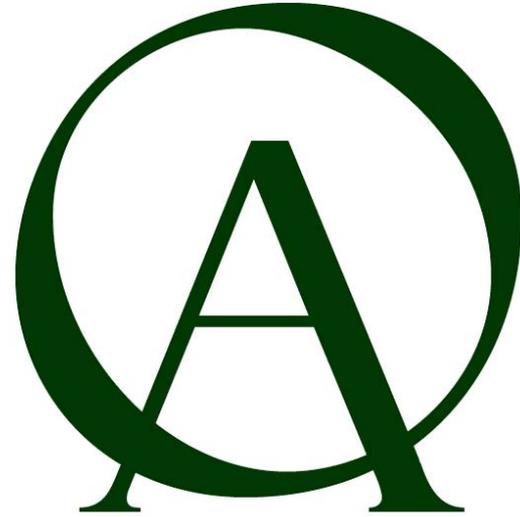
Still further out...

Rob Cook's award talk at Siggraph '09:

“...the next holy grail for the computer graphics community should be realist augmented reality.”

http://media.siggraph.org/s2009podcasts/RobCook_AwardExport.mov





OSAGE ASSOCIATES

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AR-related conferences

Gartner Wireless, Networking & Communications Summit 2010, April 19–21, San Diego, www.gartner.com/us/wireless

8th IEEE Int'l Conf. Pervasive Computing & Communications (PerCom) Mannheim (Mar 29-April 2, 2010) www.percom.org

7th IEEE Workshop on Ubiquitous Communications & Services: www.ubiquitous-management.org/mucs/2010/index.phpInt

IEEE VR March 20-26, 2010 in Waltham, Mass. <http://conferences.computer.org/vr/2010/>

IEEE Symposium on 3D User Interfaces (3DUI), March 20-21 2010, Waltham, Mass
<http://conferences.computer.org/3dui/3dui2010/>

Symposium on Haptic Interfaces March 25-26 2010, Waltham, Mass., www.hapticssymposium.org/next_conference.htm

Mobiquitous 2010 www.mobiquitous.org/

2nd ACM Int'l Workshop on Mobile Opportunistic Networking Feb. 22-23, 2010, Pisa, <http://cnd.iit.cnr.it/mobiopp2010>

2nd Int'l Conference on Mobile Lightweight Wireless Systems (MOBILIGHT 2010) www.mobilight.org

5th Int'l Conference on Body Area Networks September (BodyNets) Sept. 10-12, 2010 Corfu, Greece www.bodynets.org/

IMMERSECOM 2010 <http://immerscom.org> (2009 was at Berkeley)

2nd International Conference on Computer and Automation Engineering, Singapore Feb. 26-28, 2010 www.iccae.org/

SVC Wireless Annual Conference March 24-26, 2010, Beijing, www.svcwireless.org

Location Intelligence Conference 2009 June 2, 2010, Washington, DC www.locationintelligence.net/

3rd Int'l Conference on Mobile Ubiquitous Computing, Systems, Services & Technologies UBICOMM October 11-16, 2009 - in Sliema, Malta www.iaria.org/conferences2009/UBICOMM09.html

Int'l Symposium on Wearable Computers (ISWC'10), Seoul, Korea, October 2010. www.iswc.net/iswc10/inc_html/

2nd Int'l ICST Conference on User Centric Media, Palma de Mallorca, Sept. 1-3, 2010 www.usercentricmedia.org

GEOProcessing 2010, 2nd Int'l Conference on Advanced Geographic Information Systems, Applications, and Service Ubicomp 2010, Copenhagen. Sept. 26-29, 2010 <http://ubicomp2010.org>

Int'l Symposium on Mixed and Augmented Reality (ISMAR10) – Seoul, Korea: October, 2010 <http://ismar10.org>

8th Int'l Conference on Mobile and Ubiquitous Multimedia (MUM 2009) 22-25 Nov., Cambridge, UK www.mum2009.org

Interservice/Industry Training, Simulation and Education Conference (I/ITSEC) Orlando, FL www.iitsec.org



Credits

- *First use of term, "context awareness:* Schilit, B., Theimer, M. Disseminating Active Map Information to Mobile Hosts. IEEE Network, 8(5) (1994) 22-32
- Schilit, Bill., Adams, Norman; Want, Roy. Context-Aware Computing Applications. 1st International Workshop on Mobile Computing Systems and Applications. (1994) 85-90
- *Default Mode Network paper:* Gusnard, DA, Raichle, ME: "Searching for a baseline: the resting human brain from the perspective of functional imaging." Nature Reviews Neuroscience, 2001
- "iLamps: Geometrically Aware and Self-Configuring Projectors," Rascar, et al. 2003
- Commercial aviation HUD image courtesy Todd Lapin, cc
- MARA image courtesy Nokia Research
- Handheld AR.net (<http://handheldar.net/stbes.php>) for Studierstube ES diagram
- Fighter jet HUD device image cc www.rochesteravionicarchives.co.uk
- Photo of sail's tell-tales courtesy Bill Gracey, cc
- Modern helmet-mounted see-through display courtesy Rockwell-Collins: "SIM EYE SR100-A"
- Photo of Ray Harroun's Marmon Wasp racecar with mirror, cc The359
- Vuzix Wrap 920AV and Tac-Eye GMD images c. Vuzix Inc.
- Theme park illustrations © Chimera Design, 2007-2009
- Photo of Dubailand model © Lynne LaCascia, 2009
- Photo of Alfred North Whitehead from Wikipedia.org
- Photo of Mark Weiser from the PARC memorial page.
- Photo of BMW E60 HUD by Sebastian Klein
<http://commons.wikimedia.org/wiki/File:E60hud.JPG>

