Liquid Software in a Programmable World

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Programmable Web
Programmable Web
Programmable Money
Programmable Web
Programmable Money
Programmable World
Every Thing is Connected
Roomba requires your attention
Clear Roomba's main brushes.

Front Yard is offline. It might be because of an electrical outage, someone unplugging the camera or a bad Internet connection.
Every Thing as a Service
Services
Interoperability
Availability
Composition
Microservices
Microservices
Continuous Change
Microservices

Continuous Change

Small Size or Low Coupling?
Microservices
Continuous Change
Small Size or Low Coupling?
Recomposition
There's an app adapter for that
API Connectors
API Connectors

- File Transfer
- Remote Procedure Call
- Stream
- Shared Database
- Asynchronous Messaging
- World Wide Web
API Strategy
API Strategy
Open or Closed?
Some services are more equal than others
Some services are more equal than others

(The year we lost net neutrality)
Web Evolution

Re-decentralized

Centralized

Decentralized

https://scholar.social/@pautasso
dat://...
ipfs://...

https://www.twitter.com/pautasso

http://www.pautasso.info/rss.xml
Cloud
Data Exhaust
Data Exhaust

Cars aren't just engines, brakes and windows — they're computers on wheels that are learning to drive themselves, talk to each other, and generate enormous amounts of lucrative data that ends up into their manufacturers Cloud.
Some devices are more equal than others
Some devices are more equal than others

(The year we lost control over "our own" devices)
One Computer
Many Users
Many Computers
One User
How many Web-enabled devices do you have?

- 0
- 1
- 2
- 3
- 4
- >4

Count:

- 0
- 2
- 3
- 5
- 8

Total: 19/4
Which Web-enabled devices do you have?

- Desktop PC: 9
- Laptop: 20
- Netbook: 0
- Tablet: 11
- Smartphone: 18
- Watch: 5
- Glasses: 0
- Car: 3
- Fridge: 1

[http://www.pautasso.info/go]
Apple Continuity
What about the Web?
Liquid Metaphor
Flow
Liquid Metaphor
Flow

Liquid Metaphor

Adapt
Liquid Software

1. **Adapt** the distributed user interface to fully take advantage of the **set of** devices.
Liquid Software

1. **Adapt** the distributed user interface to fully take advantage of the **set of** devices

2. Seamlessly migrate and clone **running** applications across devices
Liquid Software

1. **Adapt** the distributed user interface to fully take advantage of the **set of** devices
2. Seamlessly migrate and clone **running** applications across devices
3. Does not **leak** into untrusted devices
Liquid User Experience

Users

Many

One

Collaboration

Responsive Sequential Screening

Migrate

Complementary Simultaneous Screening

Clone

Adapt

Flow

Active Devices

One

Many
Second Screen
Collaboration
Pre-crime
Education
Flow

How to seamlessly flow running applications across devices?

1. Migrate = Copy + Delete
2. Copy
3. Clone = Copy + Synchronize
Adapt

How to take advantage of different devices?

1. Manual
2. Automatic: Responsive (one device)
3. Automatic: Complementary (many devices)
How Liquid is the Web?
Web Architecture History

- **Web 1.0 Applications**
  - Client: View, Logic, State
  - Server: View, Logic, State
  - HTTP
    - 1995

- **Rich Web Applications**
  - Client: View, Logic, State
  - Server: View, Logic, State
  - JavaScript
    - 2002

- **Real time Web Applications**
  - Client: View, Logic, State
  - Server: View, Logic, State
  - WebSockets
    - 2008

- **Hybrid Web Applications**
  - Client: View, Logic, State
  - Server: View, Logic, State
  - WebRTC
    - 2011

- **Peer-to-Peer Web Applications**
  - Client: View, Logic, State
  - Server: View, Logic, State
  - WebComponents
    - 2011
Liquid Web Applications

Web 1.0 Applications
- View
- Logic
- State
- HTTP (1995)

Rich Web Applications
- View
- Logic
- State
- JavaScript (2002)

Real time Web Applications
- View
- Logic
- State
- WebSockets (2008)

Hybrid Web Applications
- View
- Logic
- State
- WebRTC (2011)

Peer-to-Peer Web Applications
- View
- Logic
- State
- WebComponents (2011)

Discovery
Liquid Web Applications

Migrate/Copy
- Web 1.0 Applications
- Rich Web Applications

Clone (Synchronization)
- Real time Web Applications
- Hybrid Web Applications

Peer-to-Peer Web Applications

Client
- View
- Logic
- State

Server
- View
- Logic
- State

HTTP
- 1995

JavaScript
- 2002

WebSockets
- 2008

WebRTC
- 2011

WebComponents
- 2011
State Synchronization

When to share updates?

1. Batch (Copy)
2. Trickle (Synchronize)
State Identification

What needs to be migrated/synchronized?

1. Explicit
2. Implicit
Granularity

What needs to be migrated/synchronized?

1. OS/VM (Implicit)
2. Application (Implicit)
3. Component (Explicit)
Deployment

When to install the app?

1. Pre-installed
2. On-Demand
Discovery

How to establish trust between paired devices?

1. Smartcard
2. WiFi
3. Bluetooth
4. Shared URL
5. QR Code
How to build liquid Web apps?
LIQUID.JS

Demo http://liquid.inf.usi.ch

- Liquid Web Components
- Liquid Storage (Peer-to-Peer State Synchronization)
- Liquid User Experience API
- Liquid Web Workers (Peer-to-Peer Offloading)
3 States of Software

Cloud

Liquid

Solid
A Brief History Of Liquid Software

1996  Liquid Information Environment (Frode Hegland)
2003  Fluid Computing (IBM Zurich Research Lab)
2005  Think Liquid (BEA SOA Middleware Marketing)
2008  Liquid Publications (U. Trento et al.)
2011  Liquid Web Services (USI Lugano)
2013  Liquid Web Streams (USI Lugano)
2014  Liquid Software Manifesto (TU. Tampere)
2015  Liquid Web Apps (USI Lugano & TU Tampere)
Conclusions

- Software Architectures periodically swing between:
  - Open ↔ Closed
  - Centralized ↔ Decentralized
  - Static ↔ Dynamic
  - Simple ↔ Complex

- Liquid Software flows and adapts across your trusted devices

- Liquid.js for Polymer: migrate and clone stateful Web components and peer-to-peer offloading of Web workers across multiple devices
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