Logic Vulnerabilities in eCommerce Web Applications

Giancarlo Pellegrino, Ph.D. student
giancarlo.pellegrino@{eurecom.fr, sap.com}

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About me

- PhD student at Eurécom, at Software and System Security group
- Working as research associate at SAP AG
  - Contributing to the EU funded project SPaCIoS “Secure Provision and Consumption in the Internet of Services”
- Interests in web security, security testing, browser-based security protocols, and formal analysis
- More info:
  - http://trouge.net/gp
  - http://s3.eurecom.fr/~pellegrino/index.html

What will we talk about?

- Logic Vulnerabilities
- Detection techniques
- Workflow and data flow manipulations in eCommerce Web Applications

What are logic vulnerabilities?

Logic Vulnerability

- …or design flaws/errors, business/application logic errors/flaws
- Logic Vulnerability lacks of formal definition
  - CWE-ID 840: Business Logic Error are “Weaknesses […] that commonly allow attackers to manipulate the business logic of an application.”
- Mainly caused by insufficient validation of the business process *workflow* and *data flow*
- Logic Vulnerabilities can exhibit patterns, e.g.
  - Information Exposure
  - Improper Authorization

Information Exposure: MacWorld Expo 2007

- Annually trade-show on Mac platforms
  - e.g., in 2007 Jobs unveiled the first iPhone
- Cost of “Platinum Pass” 1,695$
  - seat to see Jobs up close included
- Discount available through submission of discount codes

- Web page contained MD5 hashes and JavaScript code for client-side validation
- Codes were uppercase, 5-char long strings

„*Macworld crack offers VIP passes, hacker says*”, http://news.cnet.com/2100-1002_3-6149994.html

Improper Authentication: Business Wire 2005

- Business Wire® a press release company
- Workflow:
  1. upload news, e.g.:
     - http://website/press_relase/24/06/2013/1.html
     - http://website/press_relase/24/06/2013/2.html
  2. link the news to the user page
  3. access to the news granted only to authenticated users
- Release temporarily interrupted to avoid stock market influences
  - implemented by delaying step 2
- Lohmus Haavel & Viisemann, an Estonian company:
  - registered as user
  - wrote a spider
  - made ~$8 mil by trading the unpublished news

Source:
„Securities and Exchange Commission v. Lohmus Haavel & Viisemann”,
http://www.sec.gov/litigation/litreleases/lr19450.htm

Further examples…

… can be found here:

"*Get Rich or Die Trying*"

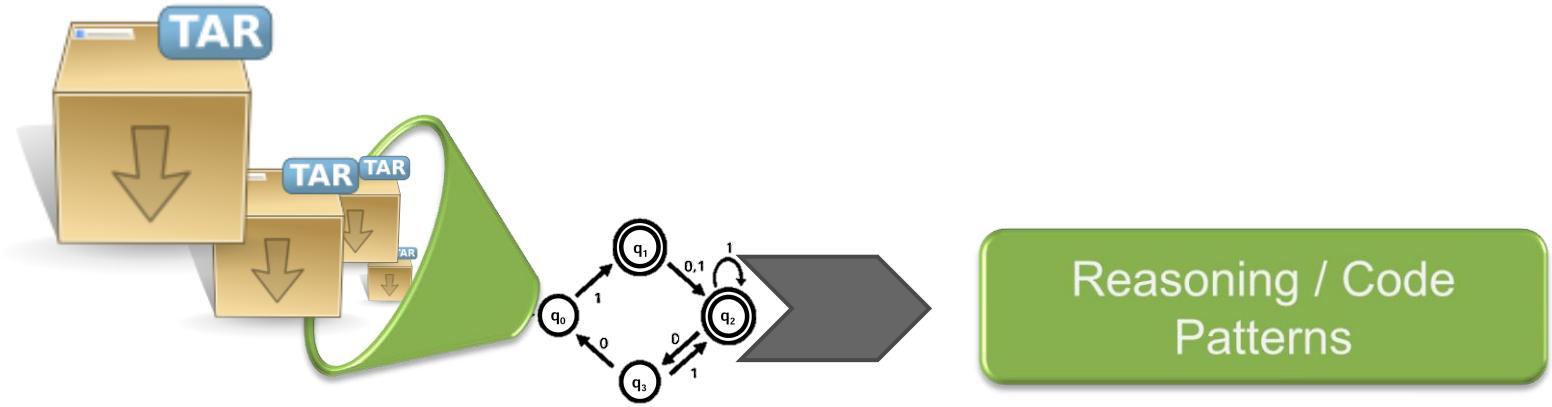
by Jeremiah Grossman
BlackHat 2009

How to detect them?

Black-box: Web Scanners

- Crawl the application, create and execute attacks, analyze the responses
- Mainly focus on injections vulnerabilities, e.g., XSS, SQLi, …
- Logic vulnerabilities out of the scope:
  - No notion of internal state

White-box: Source Code Analysis



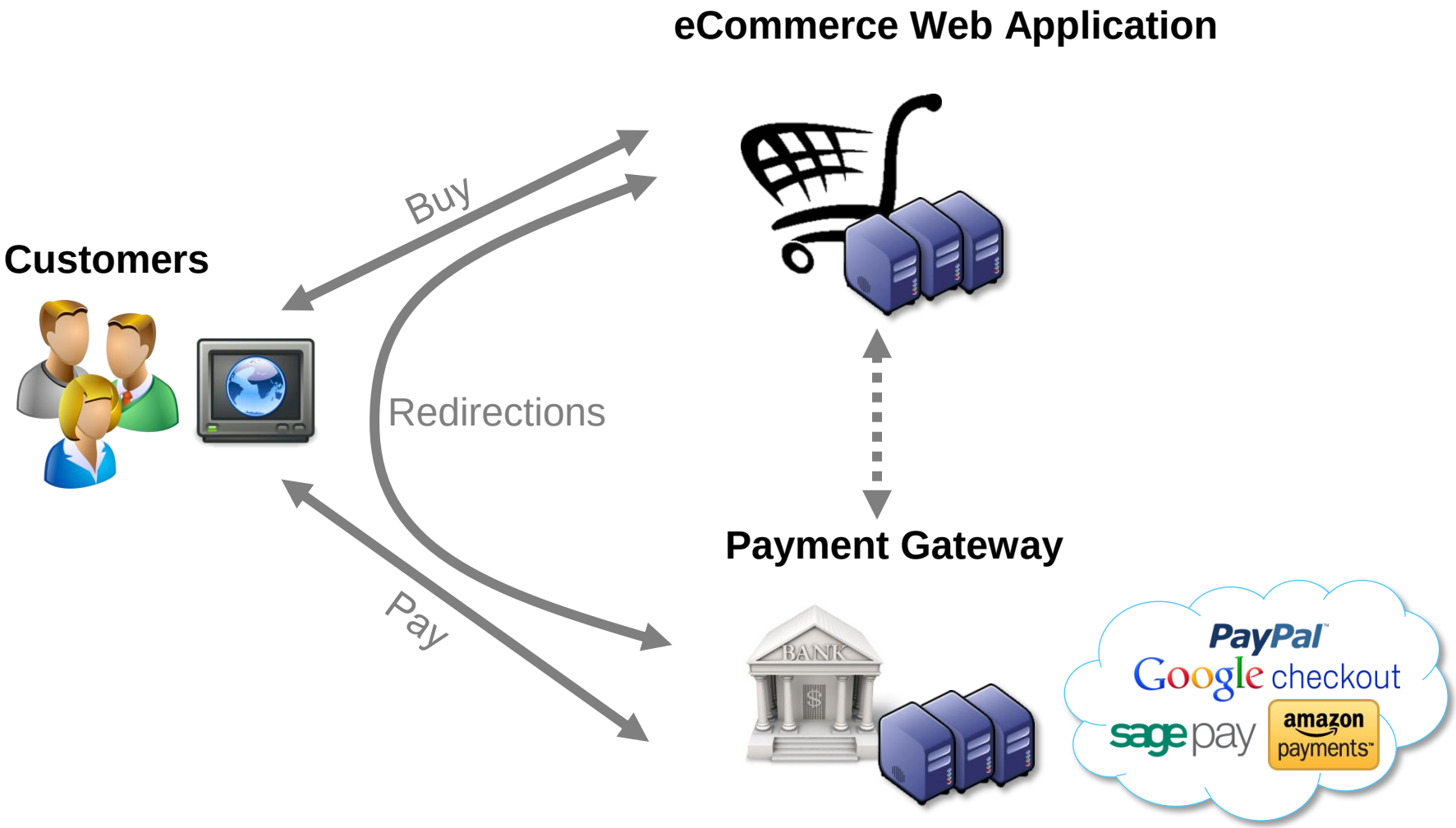
- Requires source code for building the model
- Depends on the programming language
- Academic publications:
  - "Swaddler: An Approach for the Anomaly-based Detection of State Violations in Web Applications", M. Cova, D. Balzarotti, V. Felmetsger, G. Vigna
  - "Toward Automated Detection of Logic Vulnerabilities in Web Applications", V. Felmetsger, L. Cavedon, C. Kruegel, G. Vigna

Manual testing

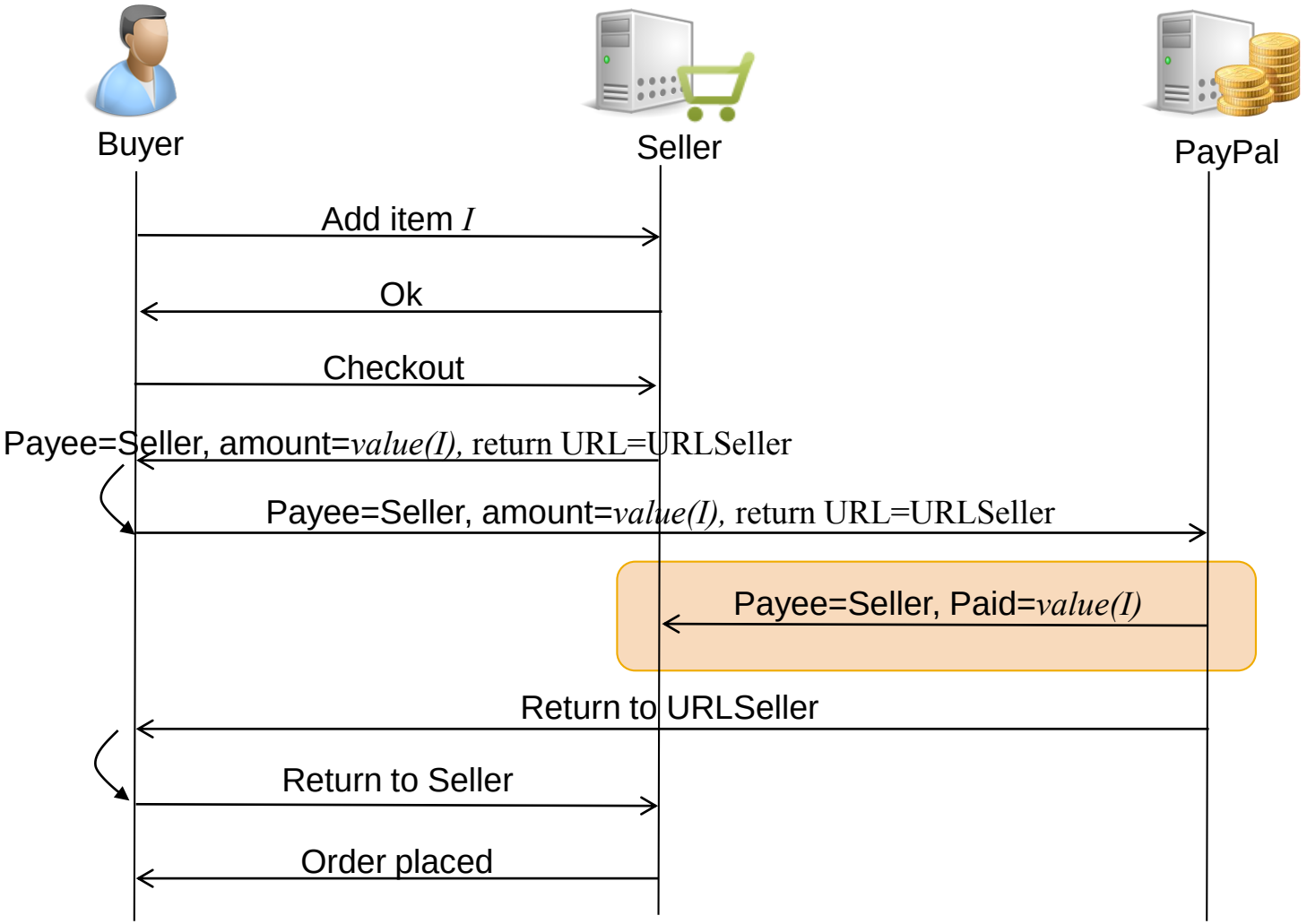
- (so far) logic vulnerabilities discovered manually
- OWASP Testing Guide 3.0 suggests:
  1. Understand the web application
     - Intended **workflow** and **data flow**
  2. Design tests violating the intended workflow and data flow
     - E.g., reorder steps, replay tokens, …
  3. Run tests and observe the result
- Little support for identifying “interesting” data values to tamper with:
  - “*How to Shop for Free Online: Security Analysis of Cashier-as-a-Service Based Web Stores*”, R. Wang, S. Chen, X. Wang, S. Qadeer
  - “*Signing Me onto Your Accounts through Facebook and Google: a Traffic-Guided Security Study of Commercially Deployed Single-Sign-On Web Services*”, R. Wang, S. Chen, X. Wang

Workflow and Data Flow manipulations

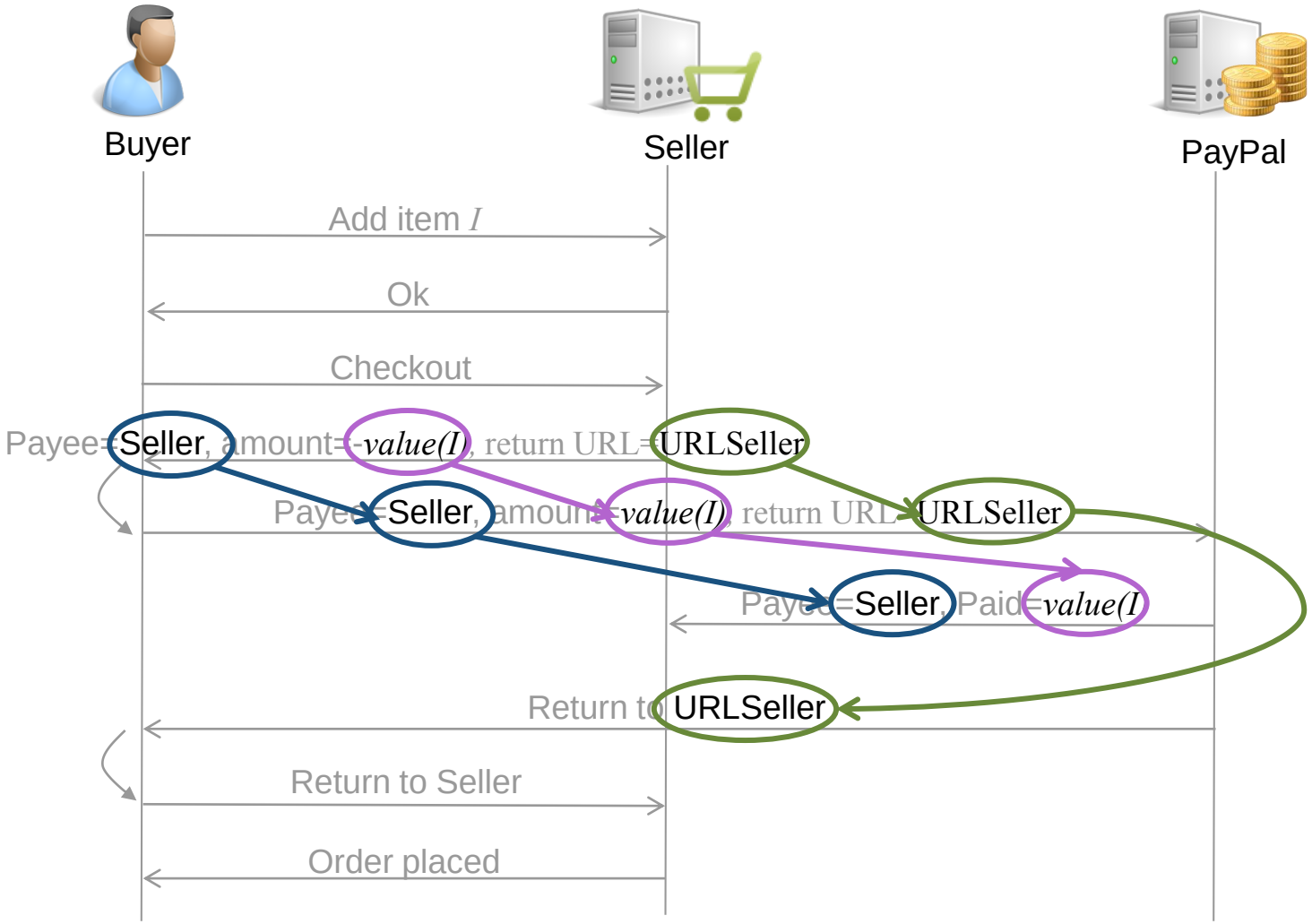
eCommerce Web Application



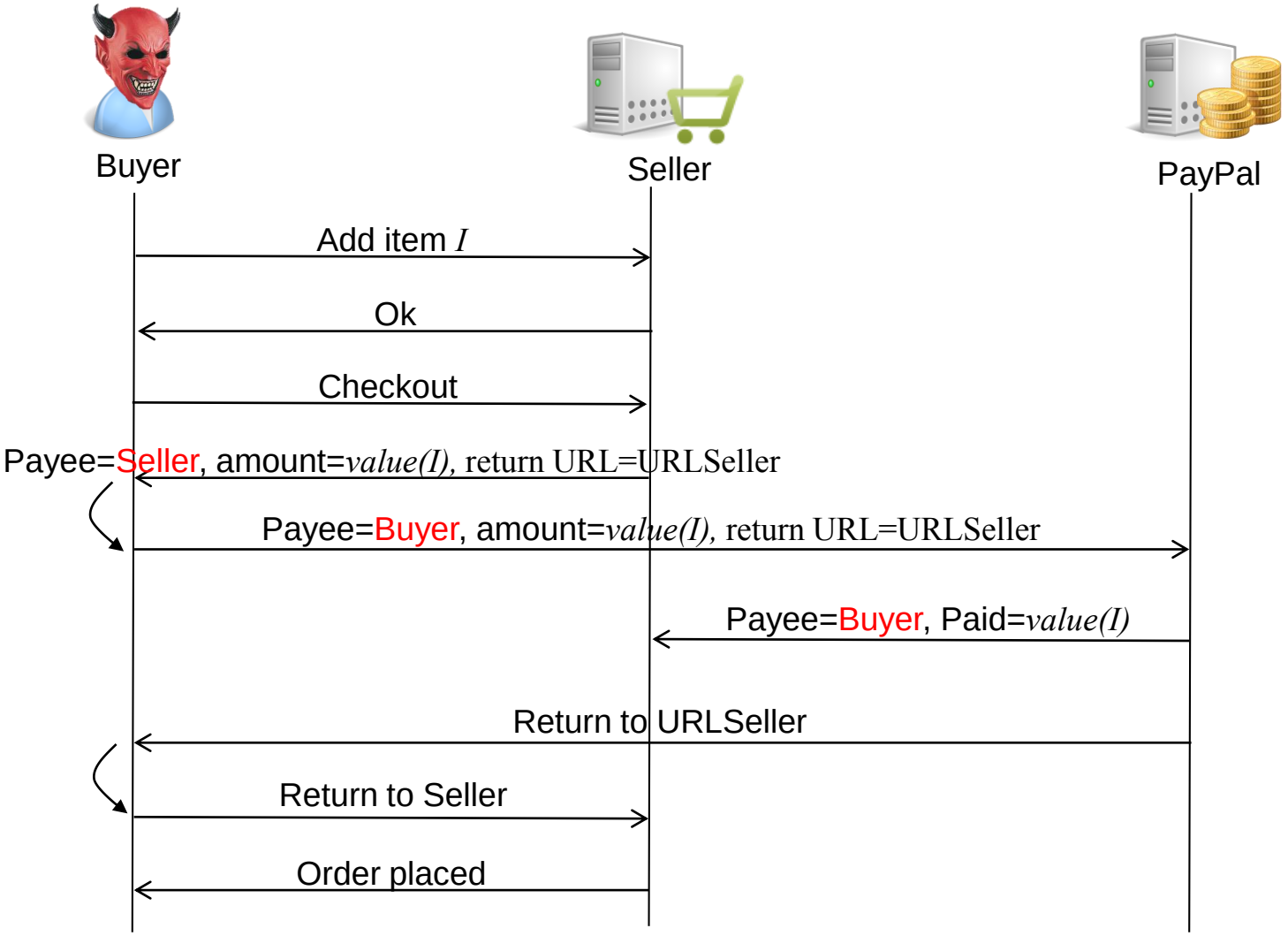
Example 1: PayPal Payments Standard & Instant Payment Notification



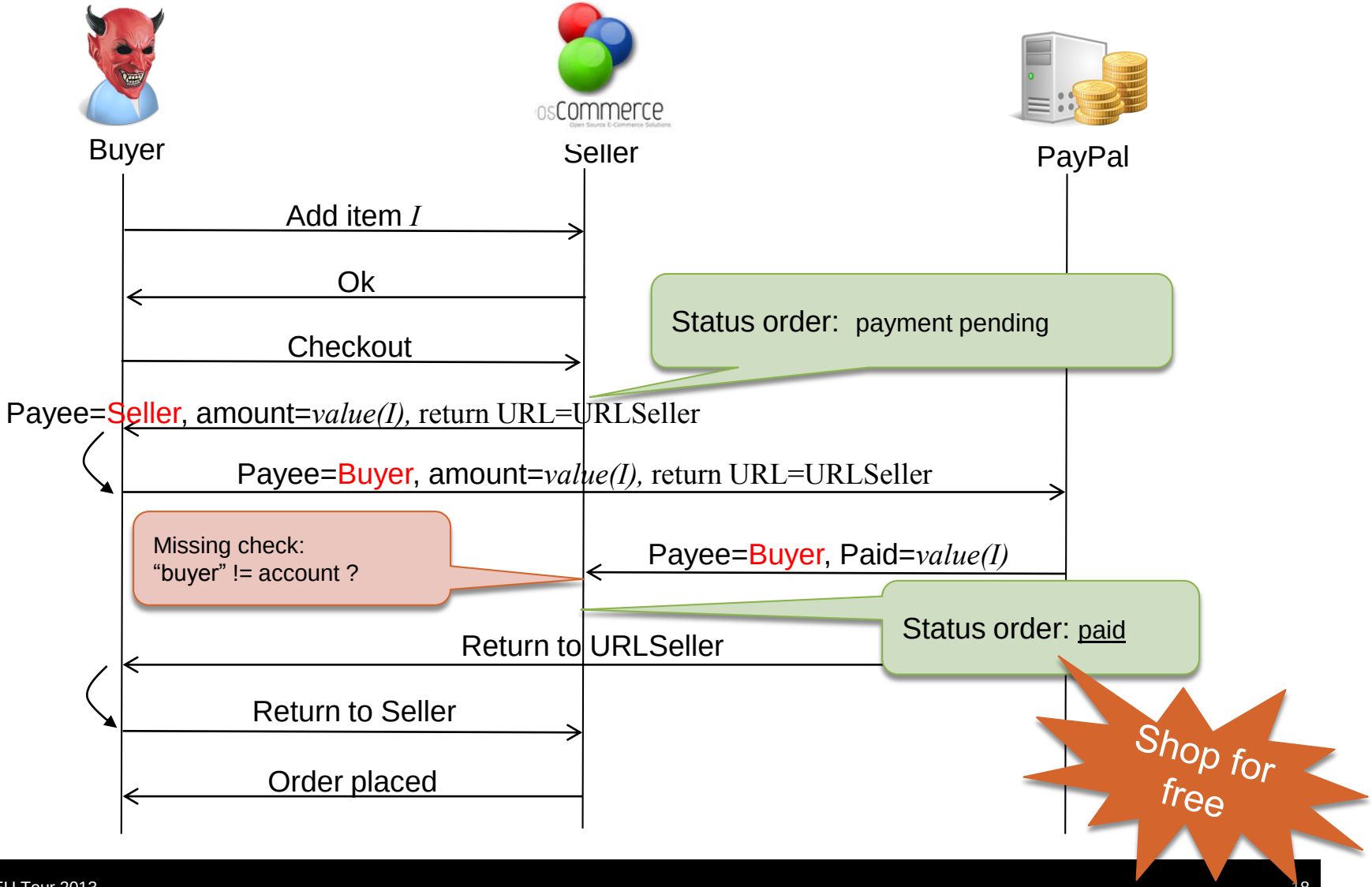
Example 1: Data flow



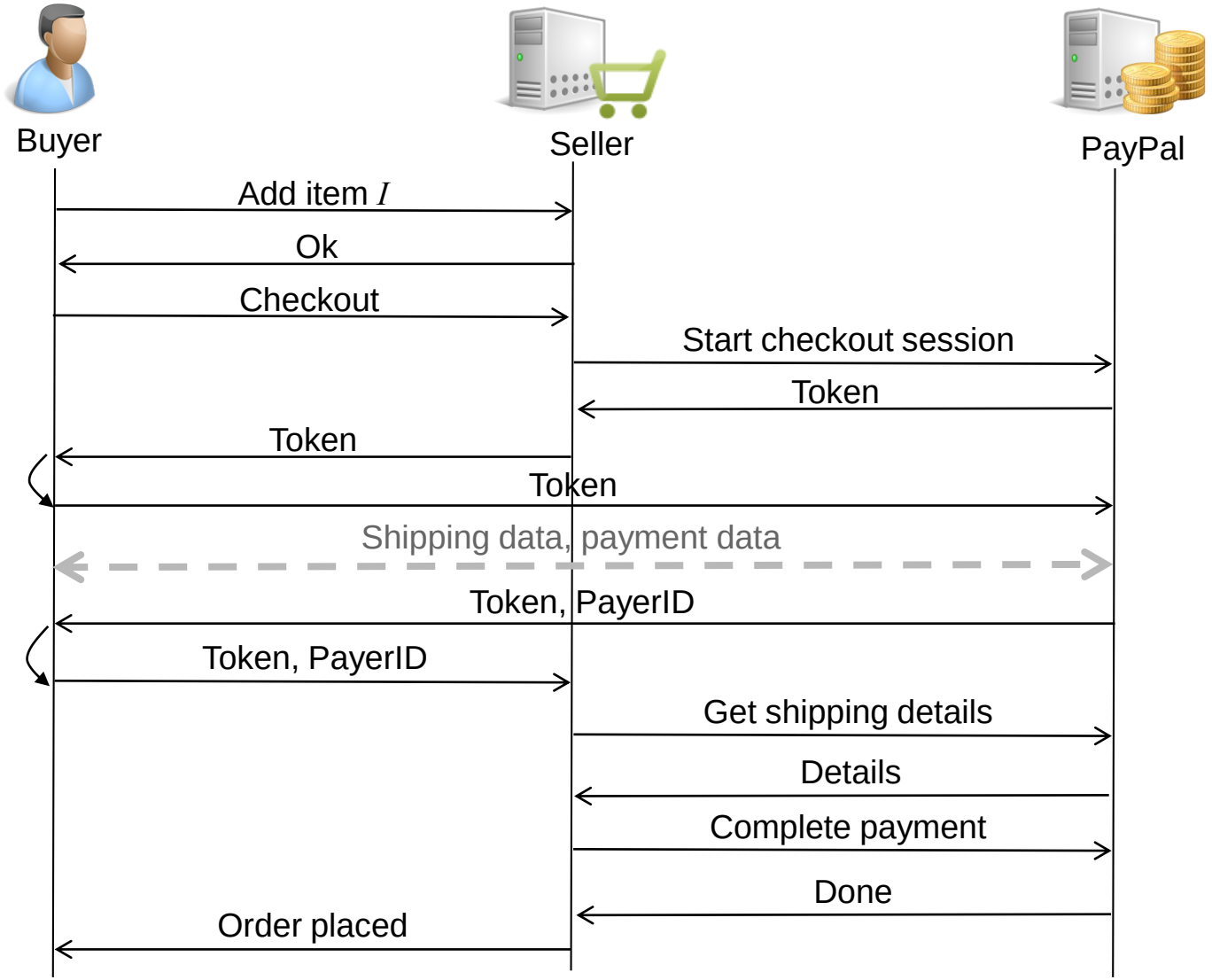
Example 1: Design (Can I pay myself?)



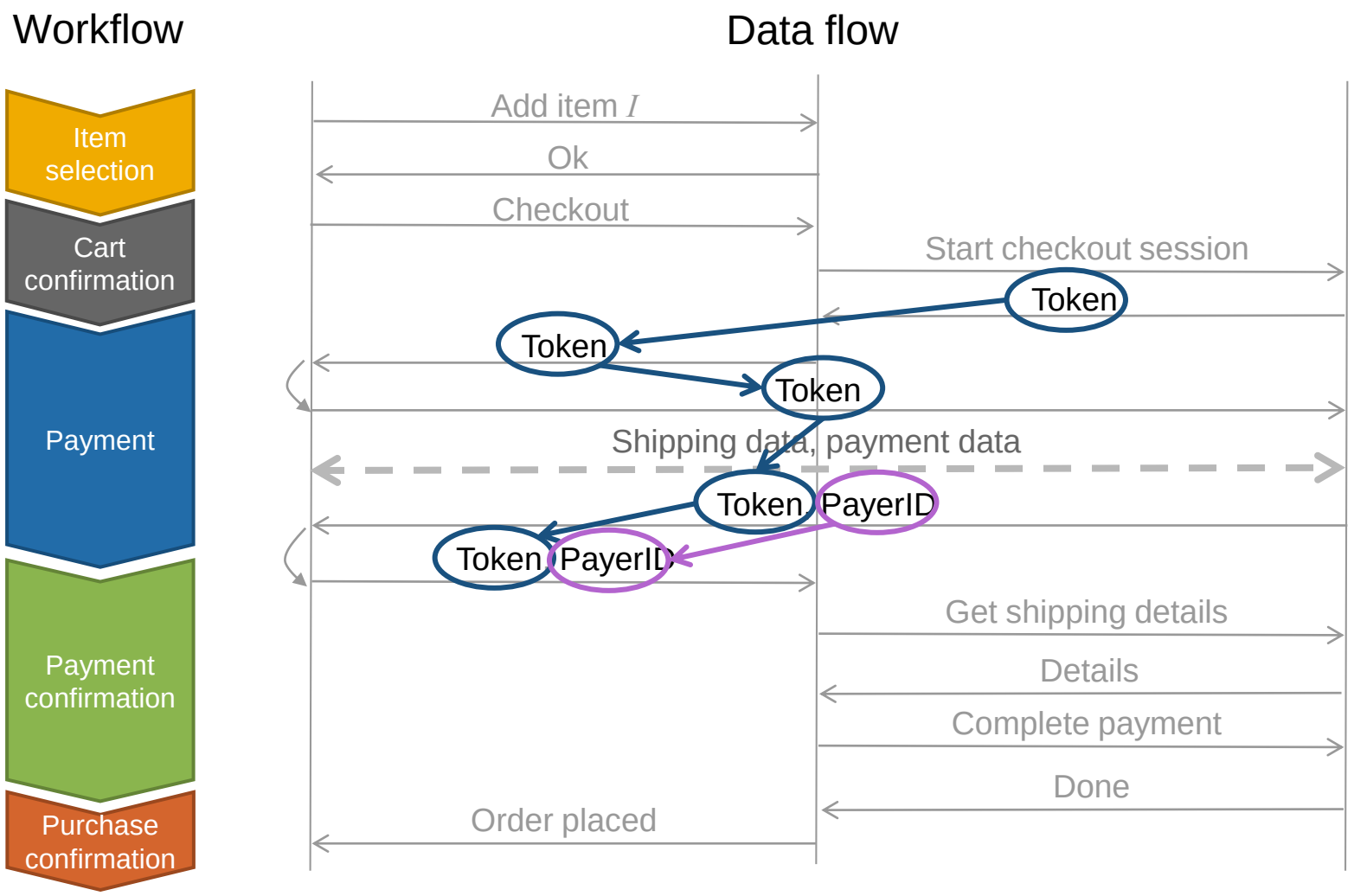
Example 1: Execution and Assessment



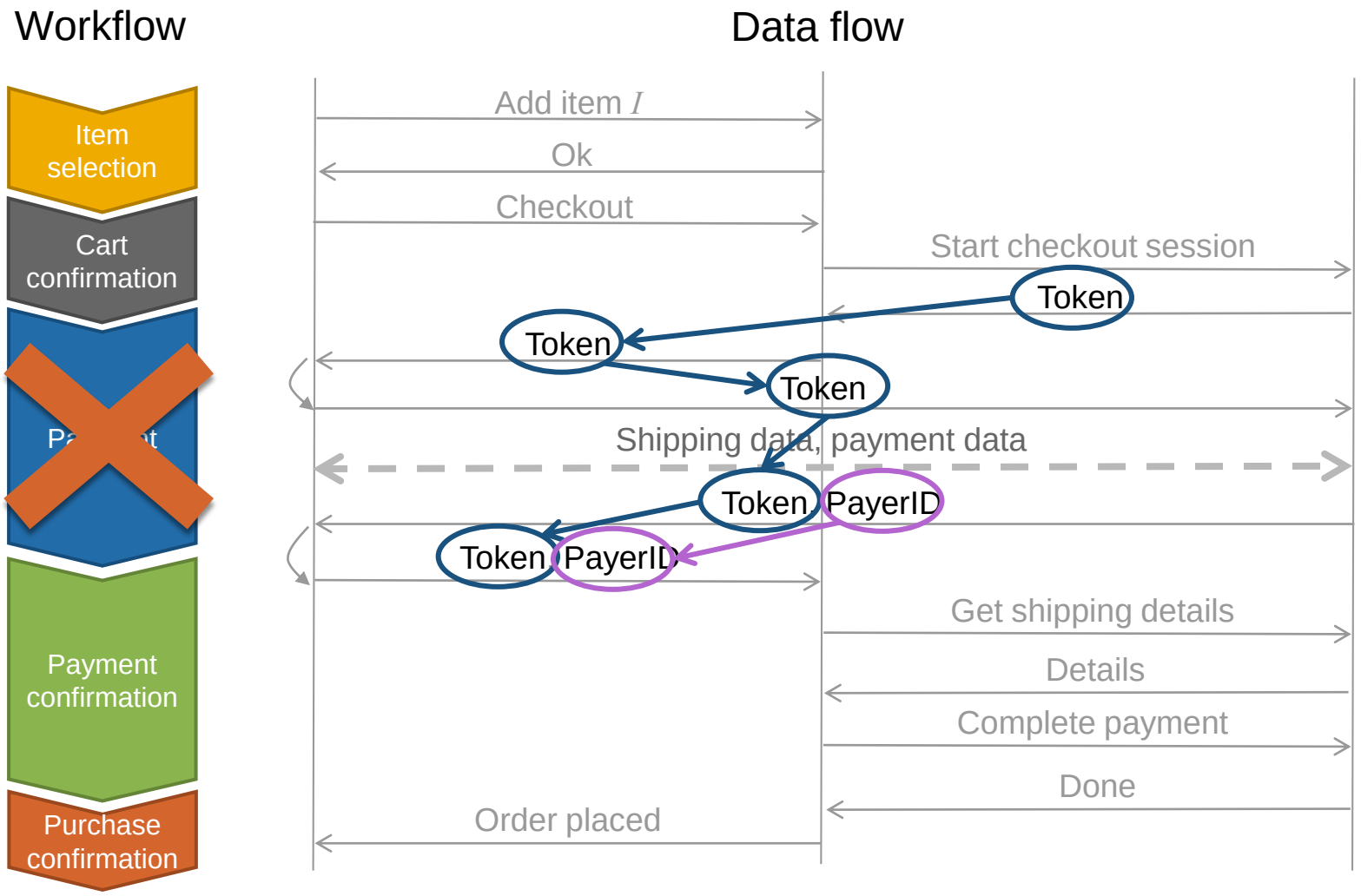
Example 2: PayPal Express Checkout



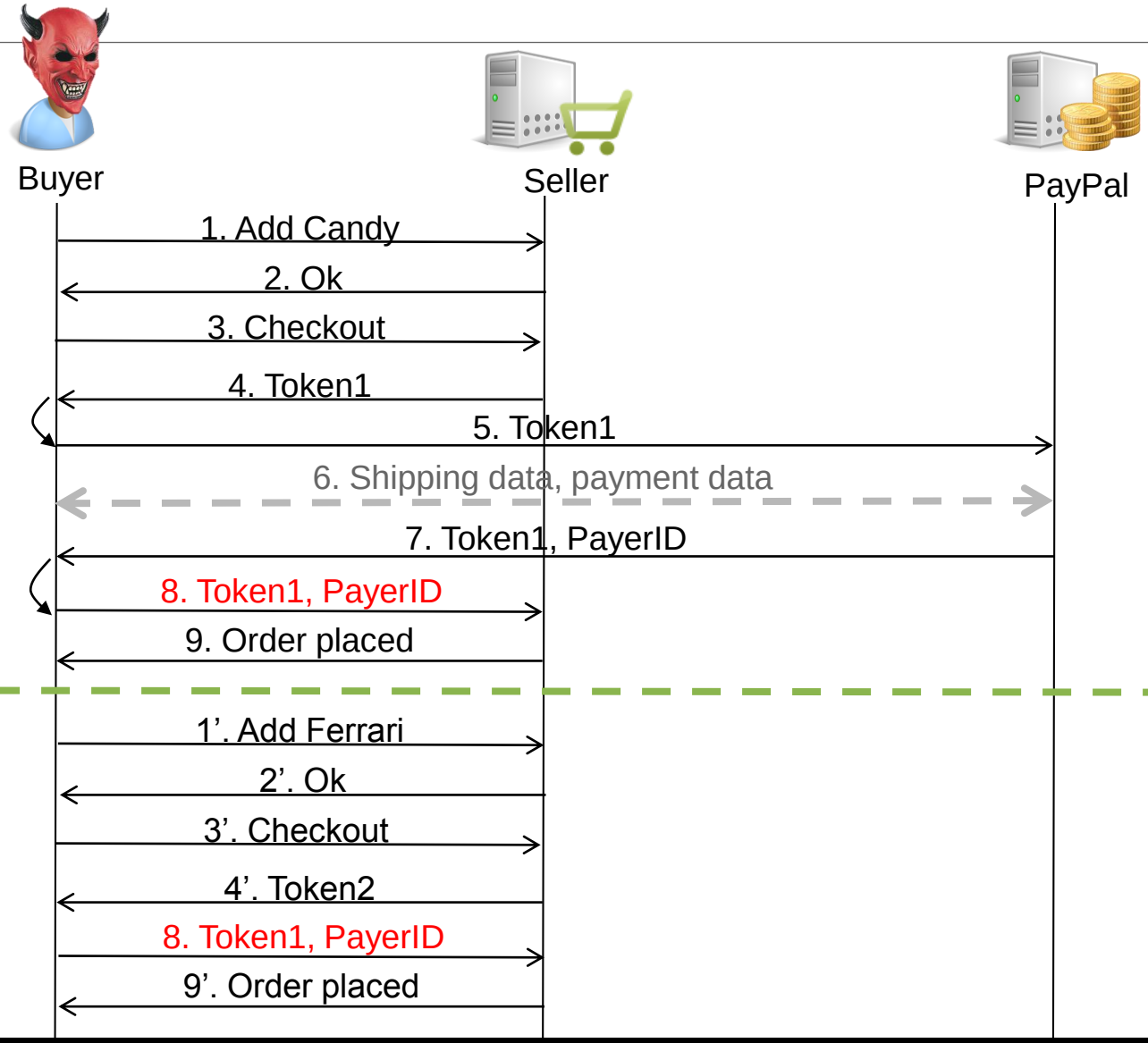
Example 2: Workflow and Data flow



Example 2a: Design (No payment)



Example 2a: Design (No payment)



Example 2a: Execution and Assessment

Buyer

tomato Cart

Seller

PayPal

User Session 1

1. Add Candy

2. Ok

3. Checkout

4. Token1

5. Token1

6. Shipping data, payment data

7. Token1, PayerID

8. Token1, PayerID

9. Order placed

Status order Candy: payment pending

Status order Candy: paid

User Session 2

1'. Add Ferrari

2'. Ok

3'. Checkout

4'. Token2

8. Token1, PayerID

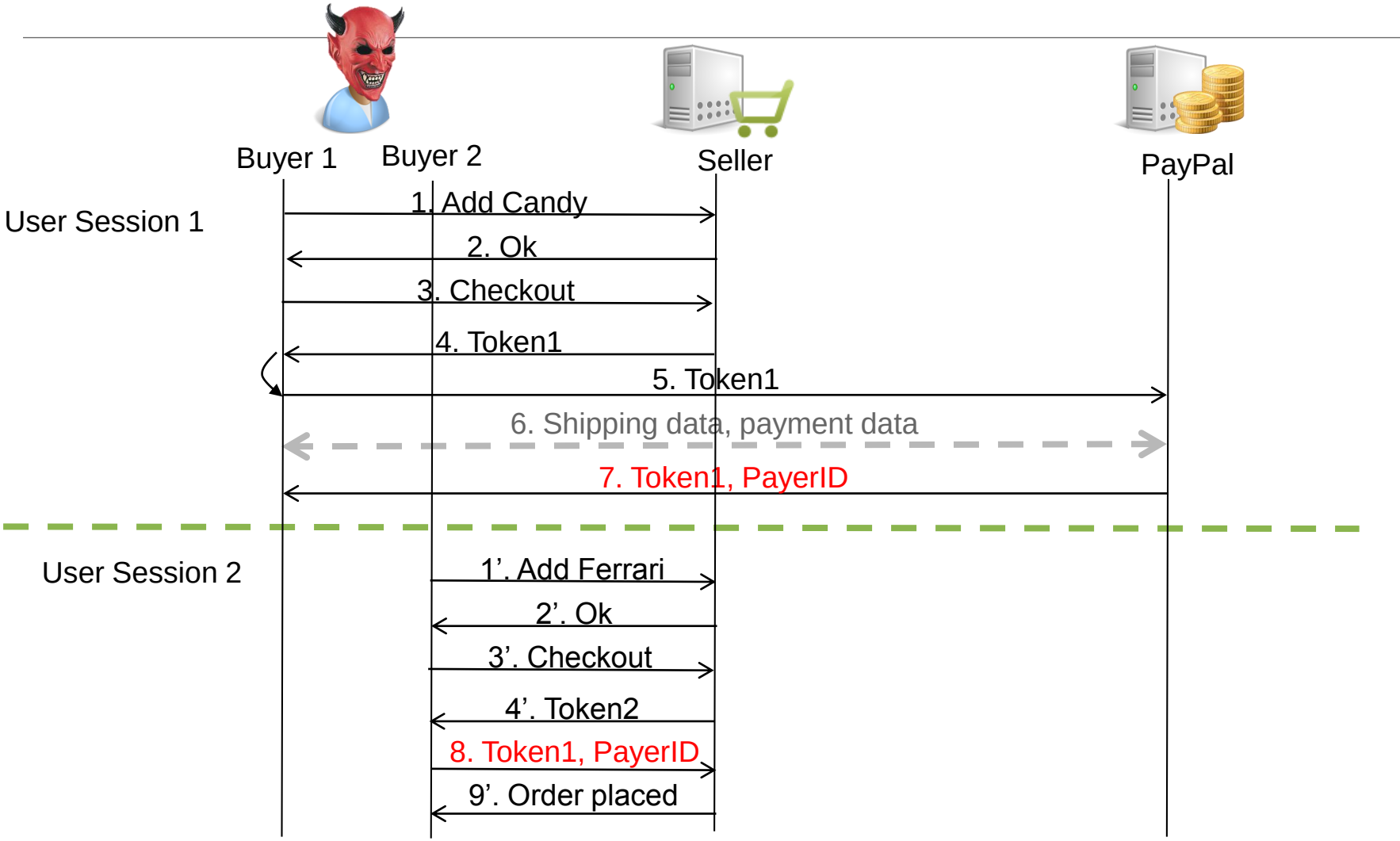
9'. Order placed

Status order Ferrari: payment pending

Status order Ferrari: paid

Pay less

Example 2b: Design (No payment and no confirmation)



Example 2b: Execution and Assessment

Buyer 1 Buyer 2 Seller PayPal

User Session 1

1. Add Candy
2. Ok
3. Checkout
4. Token1
5. Token1
6. Shipping data, payment data
7. Token1, PayerID

Status order Candy: payment pending

User Session 2

1'. Add Ferrari
2'. Ok
3'. Checkout
4'. Token2
8. Token1, PayerID
9'. Order placed

Status order Ferrari: payment pending

Status order Ferrari: paid

Shop for free

Summing up

- Logic vulnerabilities
  - Mainly caused by insufficient validation of workflow and data flow
- Hard to discover
- Detection done manually
- Simple manipulation of the workflow and data flow have a great impact

Questions?

Contact information:

Giancarlo Pellegrino
giancarlo.pellegrino@{eurecom.fr, sap.com}

References

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