

	NSu	NSu	NSu	NSu	NSu	NSu	S	S	WS	NWS	WS							
Oswaldtwistle, Fielding Lane, Plough Inn.....dep	0704	0735	0805	.....	.....	0855	.....	.....	1035	NSu	.....	1135	1205	NSu	1235	.....	.....	.....
ALDTWISTLE, Rhyddings St. ... "	0708	0738	0808	0833	0850	0908	0938	1008	1038	.....	1108	1138	1208	.....	1238	1258	1308	1318
Mill Inn ..... "	0713	0743	0813	0838	0855	0913	0943	1013	1043	.....	1113	1143	1213	.....	1243	1303	1313	1323
Den Brook Inn ..... "	0718	0748	0818	0843	0900	0918	0948	1018	1048	.....	1118	1148	1218	.....	1248	1308	1318	1328
LACKBURN, Railway Station ....arr	0726	0756	0826	0851	0908	0926	0956	1026	1056	.....	1126	1156	1226	.....	1256	1316	1326	1336

# Concurrency Testing using Custom Linux Schedulers

	WS	NWS	WS	WS	NWS	WS	WS	WS	WS	NWS	WS	NWS	WS	NWS	WS	NWS	WS	
Oswaldtwistle, Fielding Lane, Plough Inn.....dep	1408	1418	1428	1448	1508	1518	1528	1548	1608	1628	1708	1718	1728	1758	1808	1818	1826	
ALDTWISTLE, Rhyddings St. ... "	1408	1418	1428	1448	1508	1518	1528	1548	1608	1628	1708	1718	1728	1758	1808	1818	1826	
Mill Inn ..... "	1408	1418	1428	1448	1508	1518	1528	1548	1608	1628	1708	1718	1728	1758	1808	1818	1826	
Den Brook Inn ..... "	1408	1418	1428	1448	1508	1518	1528	1548	1608	1628	1708	1718	1728	1758	1808	1818	1826	
LACKBURN, Railway Station ....arr	1416	1426	1436	1456	1516	1526	1536	1556	1616	1636	1656	1716	1726	1736	1756	1806	1816	1826

	WS	NWS	WS	S	NWS	S	S	NWS	S	NWS	S	NWS	S	NWS	S	NWS	S		
Oswaldtwistle, Fielding Lane, Plough Inn.....dep	1838	1858	1908	1918	1938	1958	2008	.....	2018	2038	2058	2108	2118	2138	2158	2208	.....	2218	2238
ALDTWISTLE, Rhyddings St. ... "	1838	1858	1908	1918	1938	1958	2008	.....	2018	2038	2058	2108	2118	2138	2158	2208	.....	2218	2238
Mill Inn ..... "	1843	1903	1913	1923	1943	2003	2013	.....	2023	2043	2103	2113	2123	2143	2203	2213	.....	2223	2243
Den Brook Inn ..... "	1848	1908	1918	1928	1948	2008	2018	.....	2028	2048	2108	2118	2128	2148	2208	2218	.....	2228	2348
LACKBURN, Railway Station ....arr	1856	1916	1926	1936	1956	2016	2026	.....	2036	2056	2116	2126	2136	2156	2216	2226	.....	2236	2256

Johannes Bechberger and Jake Hillion

	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S
Oswaldtwistle, Fielding Lane, Plough Inn.....dep	2308	2318	2330	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ALDTWISTLE, Rhyddings St. ... "	2308	2318	2330	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mill Inn ..... "	2313	2323	2335	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Den Brook Inn ..... "	2318	2328	2240	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
LACKBURN, Railway Station ....arr	2326	2336	2348	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

E  
 -Tues., Fris. and Suns. only.  
 -Weds., Sats. only.  
 -Sats. only.  
 -Not Weds. or Sats.

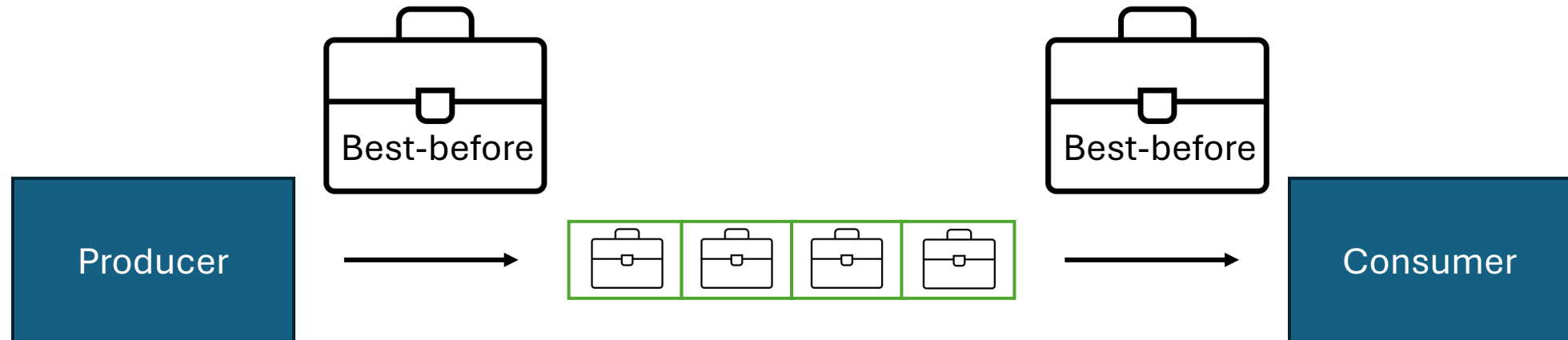
NS—Not Sats.  
 NSSu—Not Sats. or Suns.  
 NSu—Not Suns.  
 ≡—Adjoining or near Railway Station.  
 †—From Black Dog only.

†—Tues., Fris., Sats.  
 †—Works service. All other services require a ticket.  
 Local passengers are not permitted to pass the Borough of Knutsford boundary near Knutsford and Black Dog Railway Station.

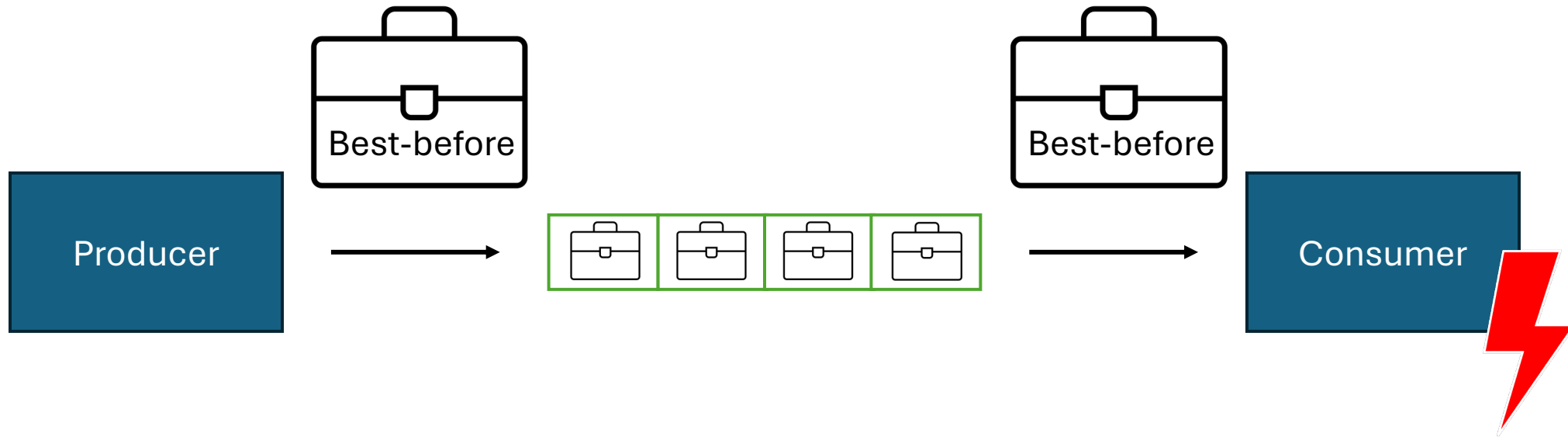


# Heisenbugs

# Consider the following

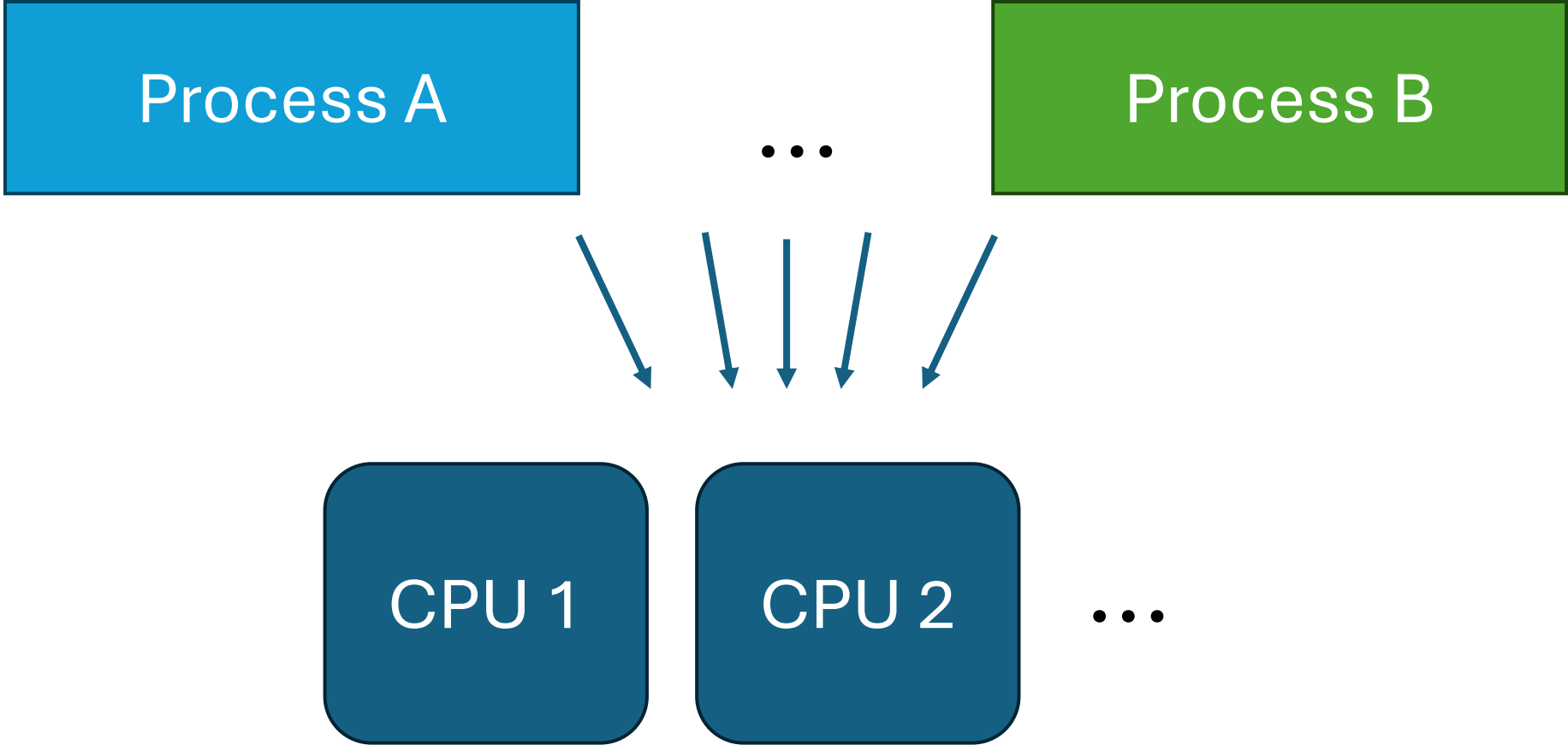


# This never crashes except when it does



This is related to  
scheduling

**What is scheduling?**



Process A

Process B



CPU



Time



Process A

Process B



CPU



Time



Time

Process A

Process B



CPU



Time

Process A

Process B



CPU



Time

Process A

Process B



CPU



Time

Process A

Process B



CPU



Time

Process A

Process B



CPU



Time





Standard schedulers  
are too good

We need an erratic  
scheduler!!!

Let's create our own

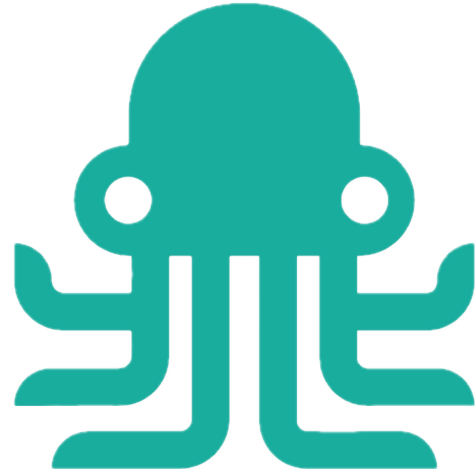
Let's create our own  
*without Kernel Development*

Let's create our own  
*in Java (or Rust)*

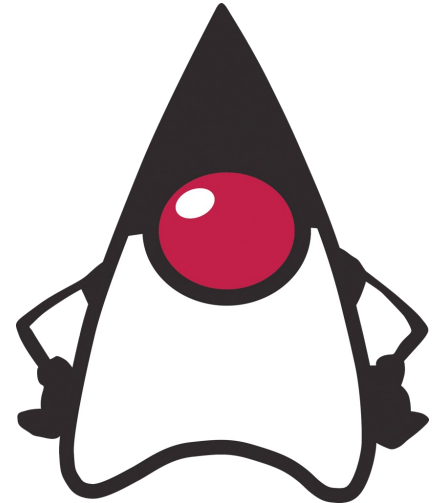
# Let's create our own



+



+





“

eBPF is a crazy technology, it's like putting JavaScript into the Linux kernel

Brendan Gregg



“

eBPF is a crazy technology, it's like putting JavaScript into the Linux kernel

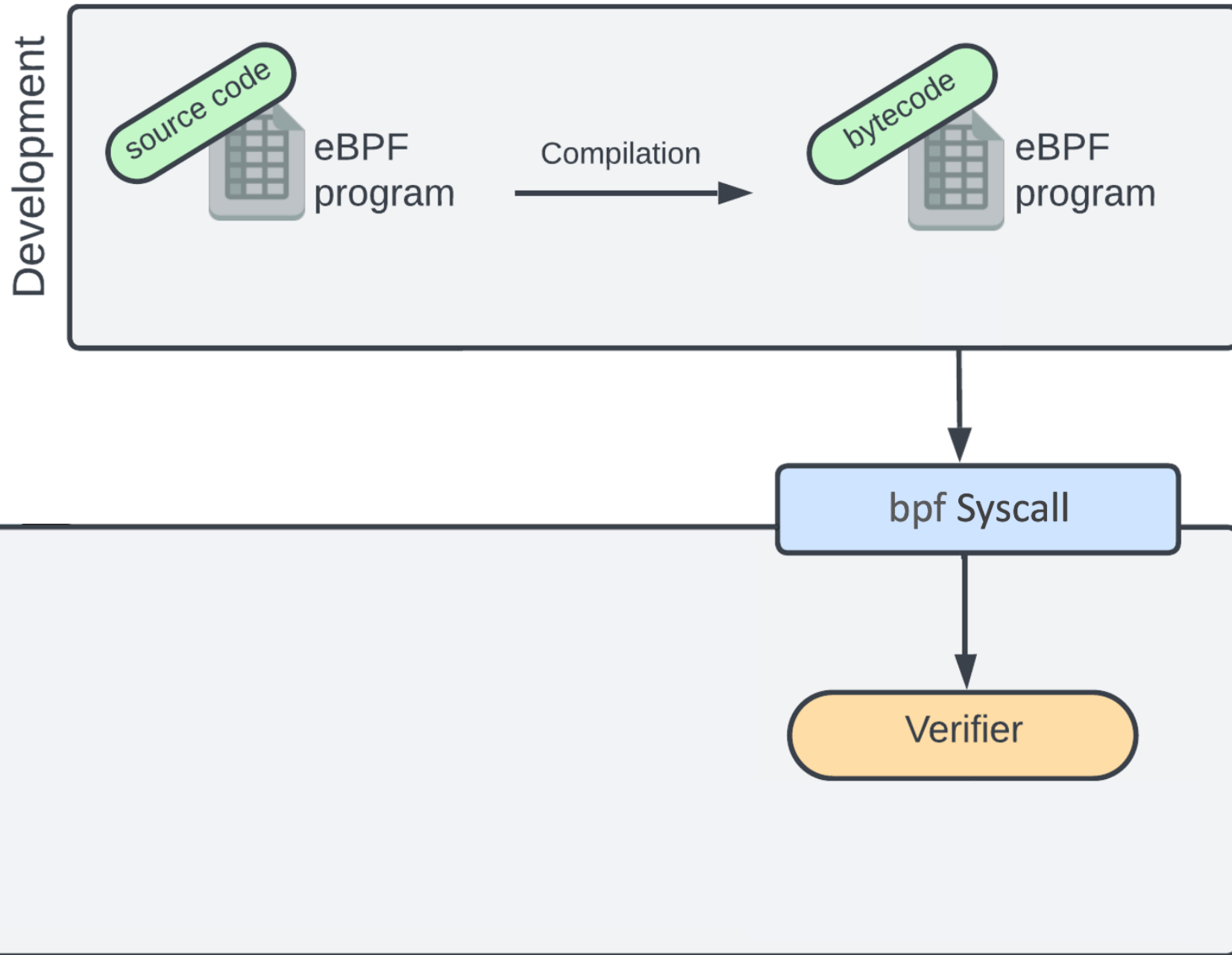
Brendan Gregg



# eBPF runtime

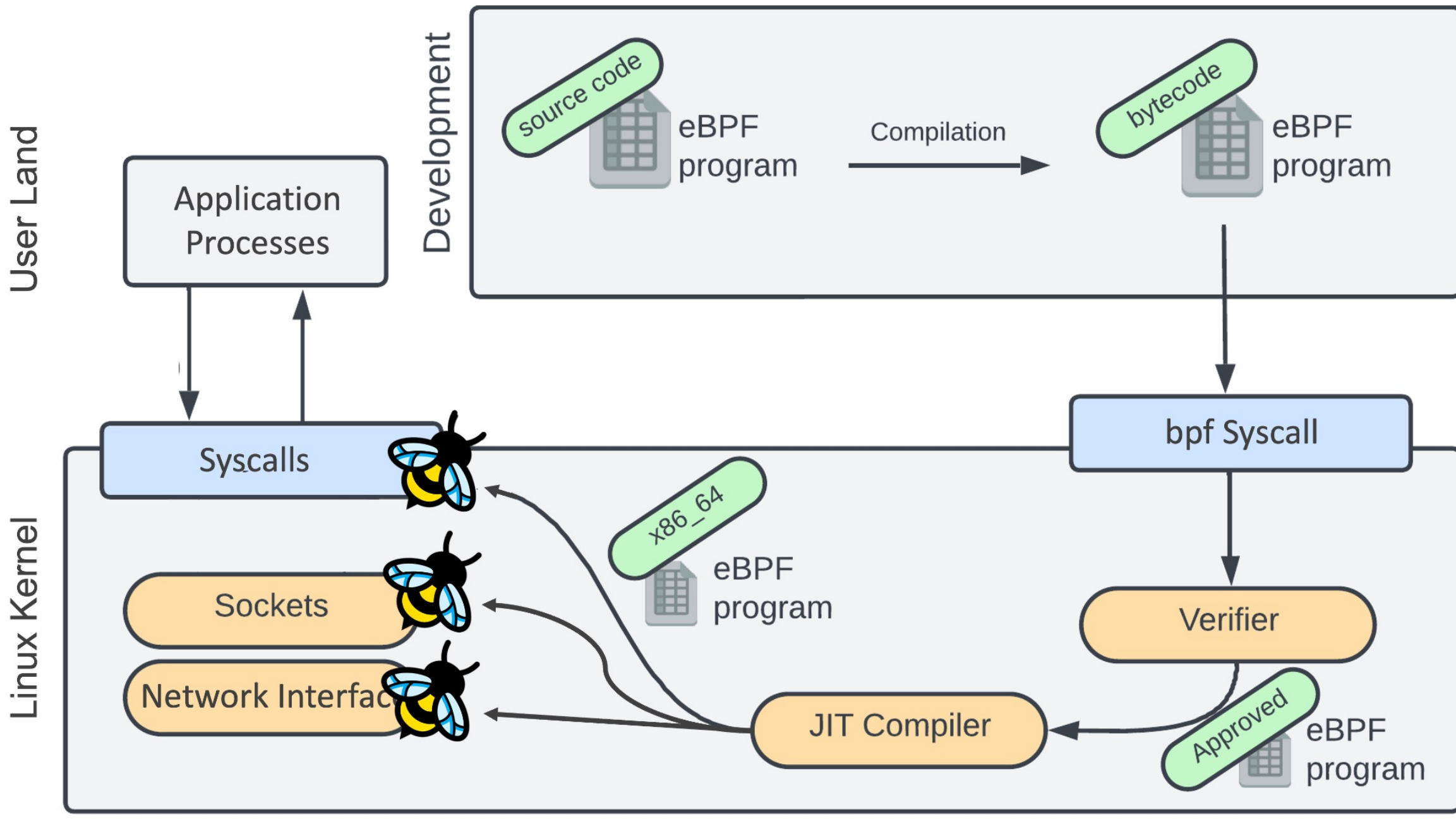


# eBPF runtime

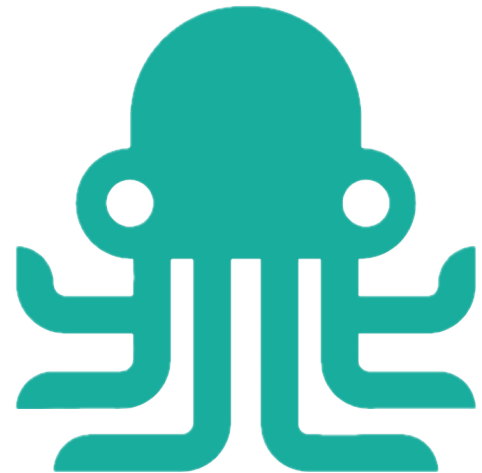


Linux Kernel

Development



Here comes  
sched-ext

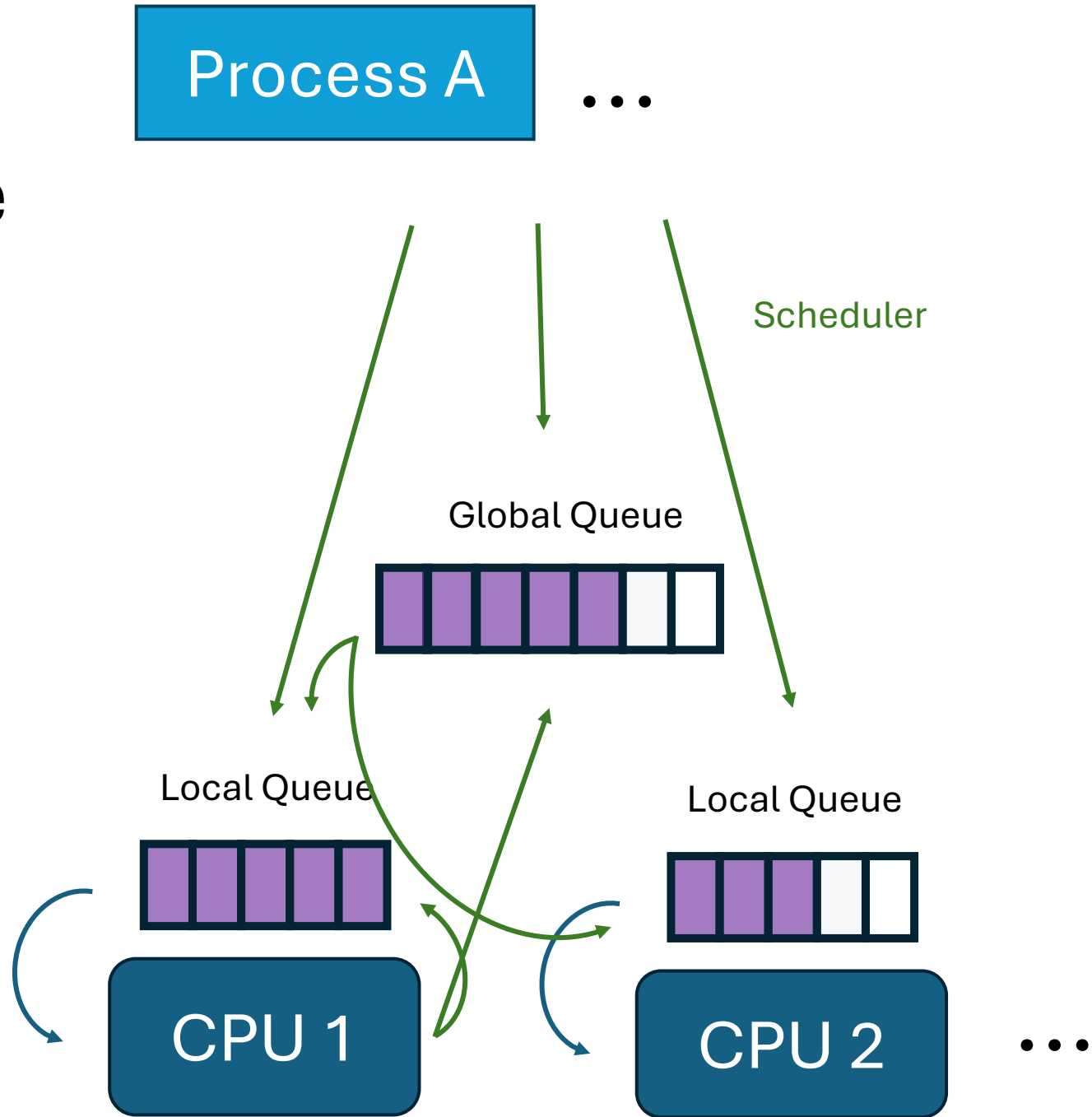


“

1. Ease of experimentation and exploration
2. Customization
3. Rapid scheduler deployments



# Scheduler dance



```
@BPF(license = "GPL")
public abstract class SampleScheduler
    extends BPFProgram implements Scheduler, Runnable {

    static final long SHARED_DSQ_ID = 0;

    @Override
    public int init() {
        return scx_bpf_create_dsq(SHARED_DSQ_ID, -1);
    }
}
```

```
@BPF(license = "GPL")
public abstract class SampleScheduler {

    @Override
    public void enqueue(Ptr<task_struct> p,
        long enq_flags) {
        scx_bpf_dispatch(p, SHARED_DSQ_ID,
            5_000_000, enq_flags);
    }

}
```

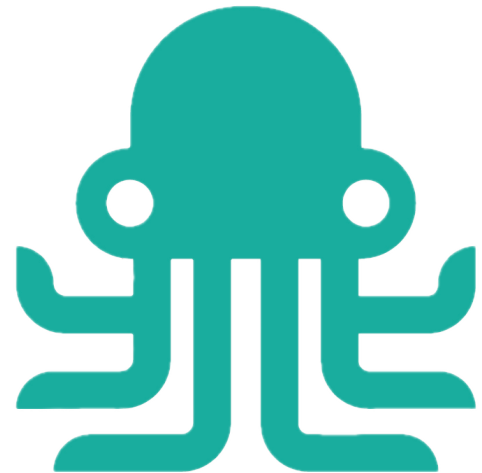


```
@BPF(license = "GPL")
public abstract class SampleScheduler {

    @Override
    public void dispatch(int cpu,
        Ptr<task_struct> prev) {
        scx_bpf_consume(SHARED_DSQ_ID);
    }

}
```

Produce erratic  
scheduling orders



# Demo



<https://github.com/parttimenerd/concurrency-fuzz-scheduler>

```
var producer = new Thread(() -> {
    while (true) {
        produce((int) (Math.random() * 100));
        sleep(20);
    }
});
producer.setName("Producer");
producer.start();
var consumer = new Thread(() -> {
    while (true) {
        consume();
        sleep(10);
    }
});
consumer.setName("Consumer");
consumer.start();
```

Demo  
Highly Experimental



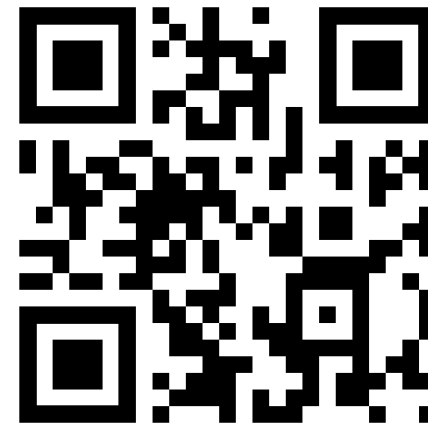
# Fin.



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OpenJDK Developer, SAP



**concurrency-fuzz-scheduler**



**Jake Hillion**  
[hillion.co.uk](https://hillion.co.uk)  
scx Developer, Meta



	NSu	NSu	NSu	NSu	NSu	NSu	S	S	WS	NWS	WS					
Oswaldtwistle, Fielding Lane, Plough Inn.....dep	0704	0735	0805	.....	0855	.....	1035	1135	1205	1235	.....					
ALDWTWISTLE, Rhyddings St. ....	0708	0738	0808	0833	0850	0908	0938	1008	1038	1108	1138	1208	1238	1258	1308	1318
Mill Inn .....	0713	0743	0813	0838	0855	0913	0943	1013	1043	1113	1143	1213	1243	1313	1323	1336
Knuzden Brook Inn .....	0718	0748	0818	0843	0900	0918	0948	1018	1048	1118	1148	1218	1248	1318	1328	1336
BLACKBURN, Railway Station .....	0726	0756	0826	0851	0908	0926	0956	1026	1056	1126	1156	1226	1256	1326	1336	1336
	WS	NWS	WS	WS	NWS	WS	WS	WS	WS	WS	NWS	WS	NWS	WS	NWS	WS
Oswaldtwistle, Fielding Lane, Plough Inn.....dep	.....	1357	1435	.....	.....	.....	1535	1635	.....	.....	.....	.....	.....	.....	.....	1757
ALDWTWISTLE, Rhyddings St. ....	1358	1408	1418	1438	1458	1508	1518	1538	1558	1618	1638	1658	1708	1758	1808	1818
Mill Inn .....	1403	1413	1423	1443	1503	1513	1523	1543	1603	1623	1643	1703	1713	1803	1813	1818
Knuzden Brook Inn .....	1408	1418	1428	1448	1508	1518	1528	1548	1608	1628	1648	1708	1718	1808	1818	1826
BLACKBURN, Railway Station .....	1416	1426	1436	1456	1516	1526	1536	1556	1616	1636	1656	1716	1726	1816	1826	1836
	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS
Oswaldtwistle, Fielding Lane, Plough Inn.....dep	1835	.....	.....	.....	.....	7TFSu	1	.....	.....	.....	.....	.....	.....	.....	.....	2235
ALDWTWISTLE, Rhyddings St. ....	1838	1858	1903	1916	1926	1936	1946	1956	2006	2016	2026	2036	2046	2056	2066	2076
Mill Inn .....	1843	1903	1913	1923	1933	1943	1953	2003	2013	2023	2033	2043	2053	2063	2073	2083
Knuzden Brook Inn .....	1848	1908	1918	1928	1938	1948	1958	2008	2018	2028	2038	2048	2058	2068	2078	2088
BLACKBURN, Railway Station .....	1856	1916	1926	1936	1946	1956	2006	2016	2026	2036	2046	2056	2066	2076	2086	2096
	NS	S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Oswaldtwistle, Fielding Lane, Plough Inn.....dep	2308	2318	2328	2338	2348	2358	2408	2418	2428	2438	2448	2458	2468	2478	2488	2498
ALDWTWISTLE, Rhyddings St. ....	2313	2323	2333	2343	2353	2403	2413	2423	2433	2443	2453	2463	2473	2483	2493	2503
Mill Inn .....	2318	2328	2338	2348	2358	2408	2418	2428	2438	2448	2458	2468	2478	2488	2498	2508
Knuzden Brook Inn .....	2318	2328	2338	2348	2358	2408	2418	2428	2438	2448	2458	2468	2478	2488	2498	2508
BLACKBURN, Railway Station .....	2326	2336	2346	2356	2406	2416	2426	2436	2446	2456	2466	2476	2486	2496	2506	2516

THROUGH SERVICE BETWEEN OSWALDTWISTLE AND SOUTHPORT, SEE TABLE 2