Chords in C#

Introduction

- Polyphonic C# is an extension to the C# language
- Extension is aimed at providing in-language concurrency support

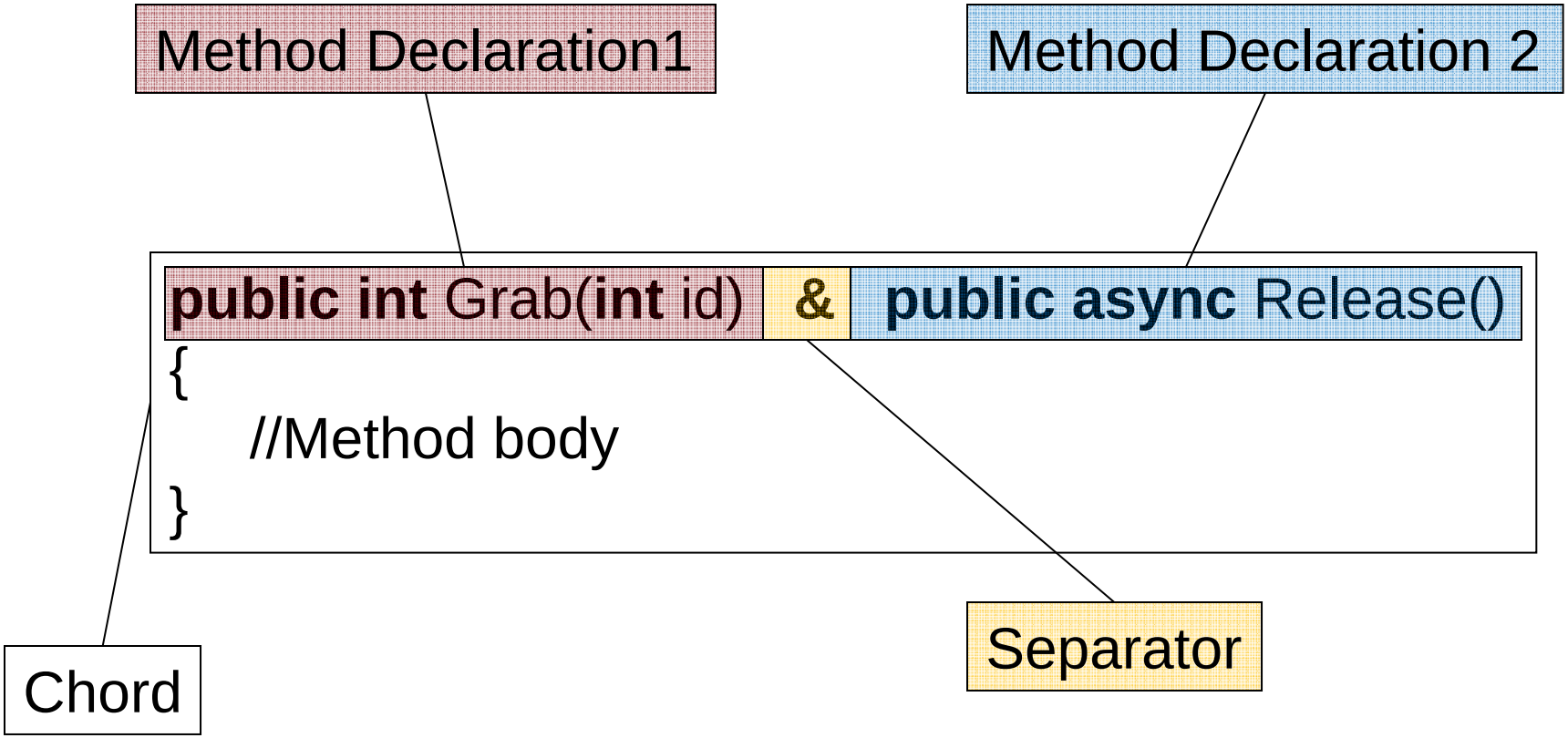
Agenda:
1. Extension Syntax
2. Rules
3. How it works
4. Translation of new constructs to traditional C#
5. An example (Stock Server : Active Object)

New Syntax

No return: Just schedule this method for execution in another thread

```
async methodName(argumentType stuff) {
        //stuff to do
}
```

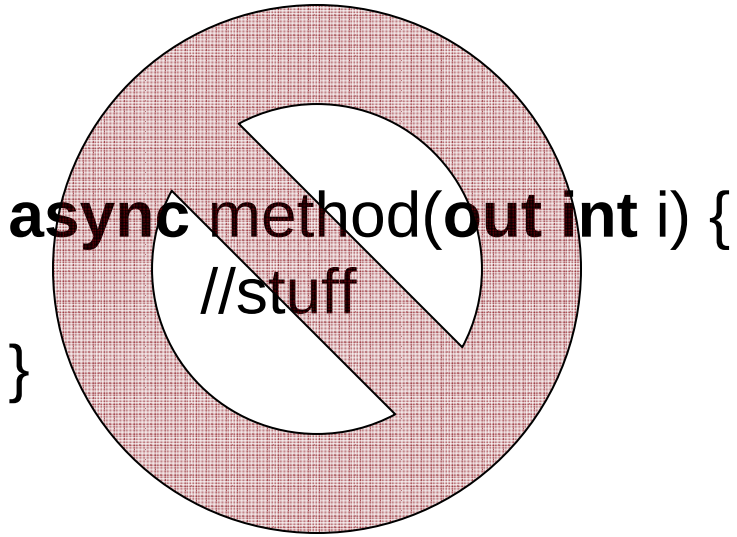
New Syntax



Chord body executes when all of the methods in the header have been called

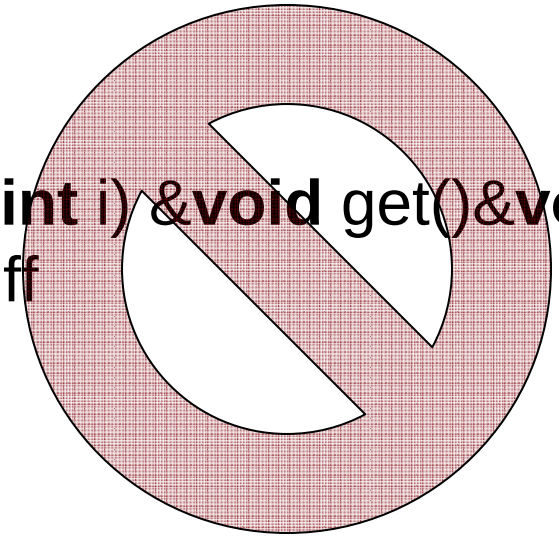
Syntax Rules – Method Declarations

"ref" and "out" parameter modifiers cannot be used in async methods because by the time this method is executed, who knows what the caller is doing?



Syntax Rules – Chord Declarations

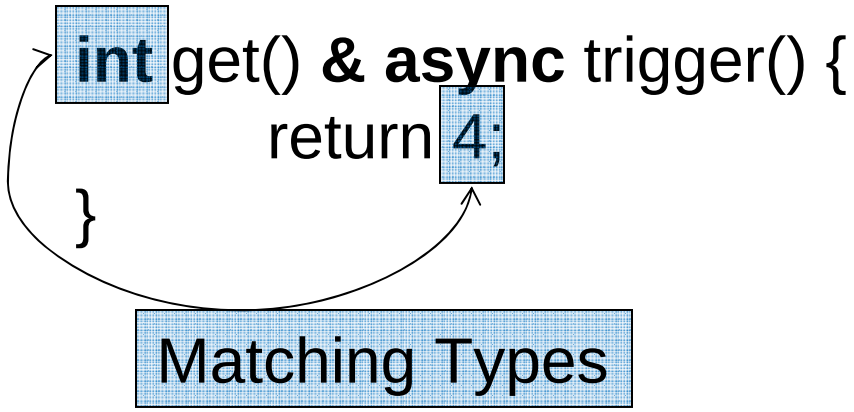
Only one synchronous method is allowed in a chord declaration. Otherwise, in which thread is the body executed? This decision could have behavioral effects.



```
async put(int i) &void get()&void calculate() {
        //stuff
}
```

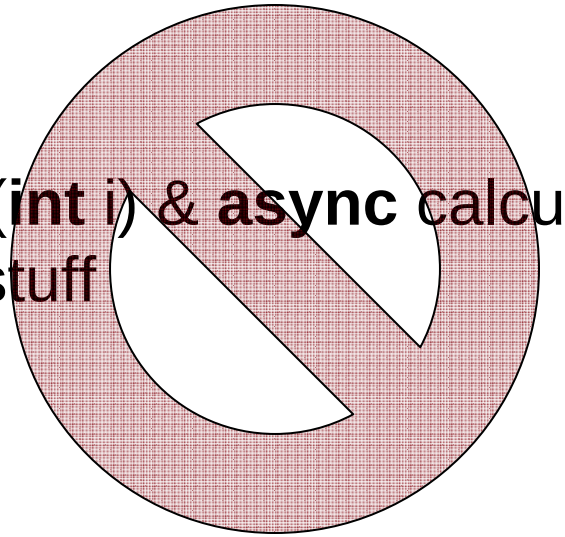
Syntax Rules – Chord Declarations

If a method header has a return value, the body can return a value of that type. If no type is provided then an empty return statement can be used.



Syntax Rules – Chord Declarations

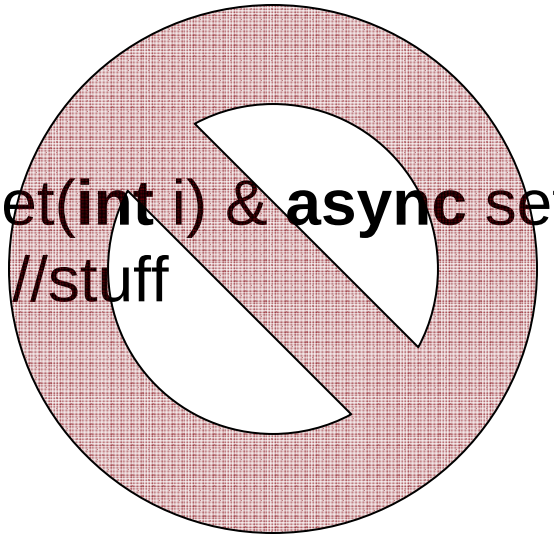
All formals appearing in method-headers must have distinct identifiers. Otherwise, there would be translation issues… we'll see how chords are translated into conventional C# later!



```
void get(int i) & async calculate(int i) {
        //stuff
}
```

Syntax Rules – Chord Declarations

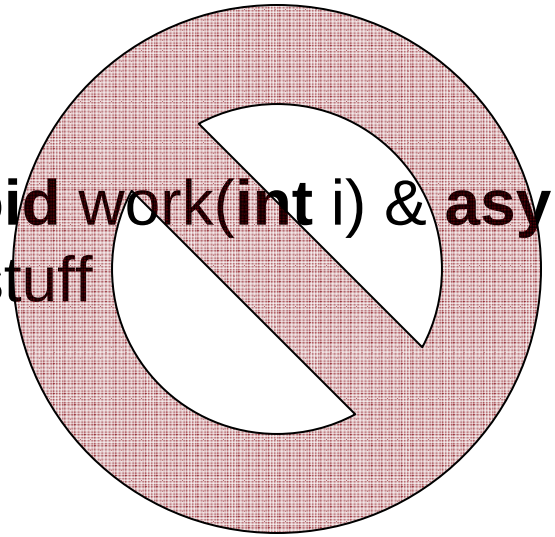
Two method headers within the same chord declaration may not have both the same method name and argument types. Otherwise, which function to call at runtime?



```
void set(int i) & async set(int  k) {
        //stuff
}
```

Syntax Rules – Chord Declarations

All method headers within a chord declaration must be either instance declarations or static declaration: Never a mix.

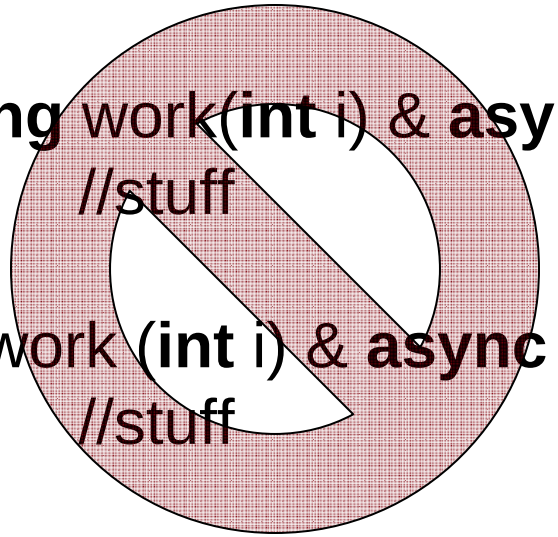


```
static void work(int i) & async set(int  k) {
        //stuff
}
```

Syntax Rules – Within a Class

All method headers with the same member name and argument type signature must have the same return type and identical sets of attributes and modifiers.

```
class c {
        string work(int i) & async set(int  k) {
                //stuff
        }
        int work (int i) & async set(int k){
                //stuff
        }
}
```

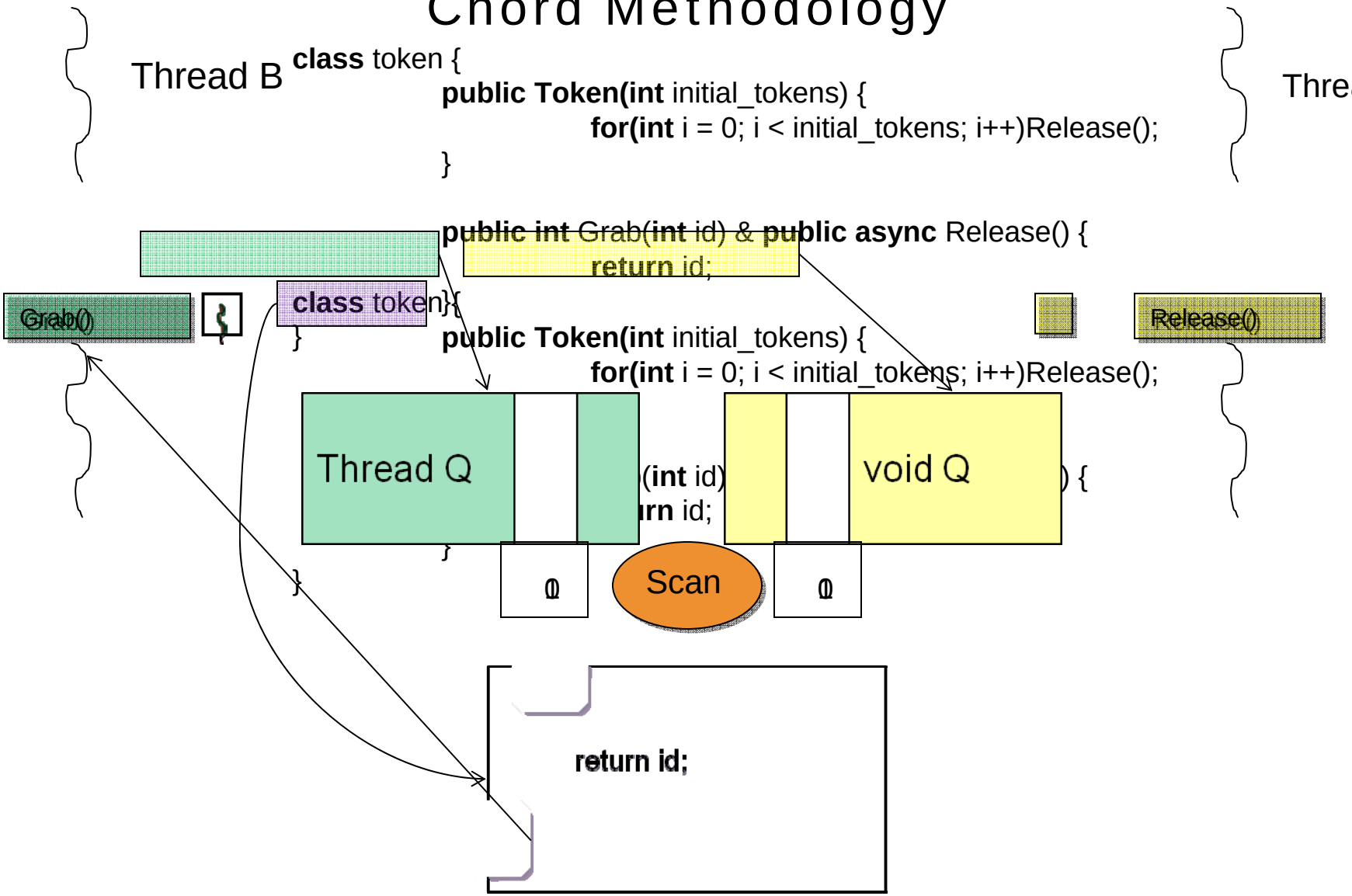


Syntax Rules – Within a Class

When methods are overridden, all their chords must also be completely overridden.

```
class C {
        virtual void f() & virtual async g() {/*stuff1*/}
        virtual void f() & virtual async h() {/*stuff2*/}
}
class D:C {
        override async g() {/*stuff3*/}                    WRONG
        override void f() & override async g(){/*new stuff 1*/}
        override void f() & override async h(){/*new stuff2*/}
                                                           Correct!
}
```

Chord Methodology



Chord Translation - BitMask

```
struct BitMask {
    private int v ; // = 0;
    public void set(int m) { v |= m; }
    public void clear(int m) { v &= ~m; }
    public bool match(int m) { return (~v & m)==0; }
}
```

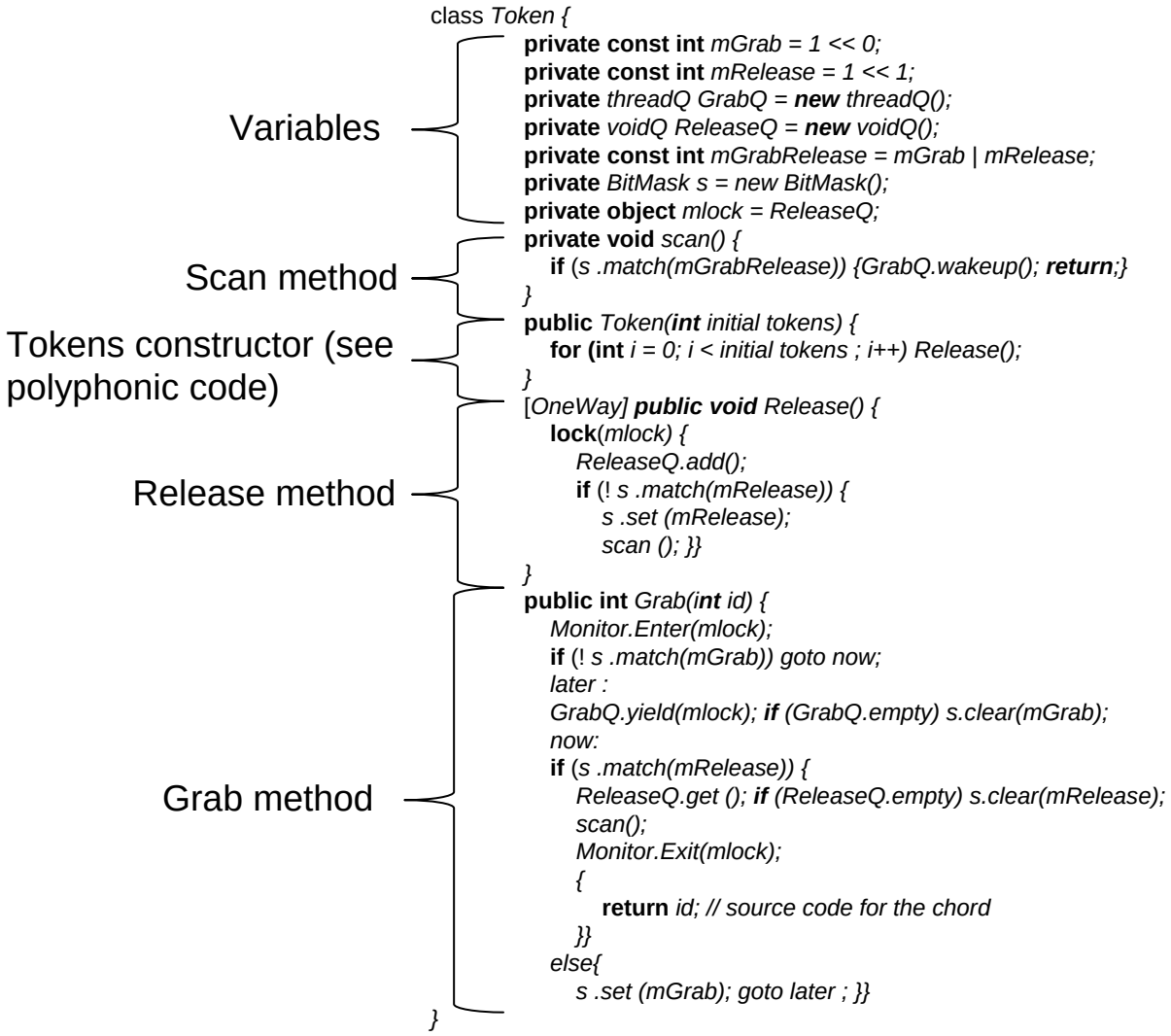
Chord Translation - VoidQ

```
class voidQ {
        private int n;
        public voidQ(){ n = 0;}
        public void add() {n++;}
        public void get() {n--;}
        public bool empty {get{return n==0;}}
}
```

Chord Translation - ThreadQ

```
class threadQ {
        private bool signalled = false;
        private int count = 0;
        public bool empty {get{return count == 0;}}
        public void yield(object myCurrentLock){
            count++;
            Monitor.Exit(myCurrentLock);
            lock(this){
                while(!signaled) Monitor.Wait(this);
                signaled = false;
            }
            Monitor.Enter(myCurrentLock);
            count--;
        }
        public void wakeup(){
            lock(this){
                signaled = true;
                Monitor.Pulse(this);
            }
        }
}
```

Chord Translation – Token Example Class




```
class Token {
    private const int mGrab = 1 << 0;
    private const int mRelease = 1 << 1;
    private threadQ GrabQ = new threadQ();
    private voidQ ReleaseQ = new voidQ();
    private const int mGrabRelease = mGrab | mRelease;
    private BitMask s = new BitMask();
    private object mlock = ReleaseQ;
    private void scan() {
        if (s .match(mGrabRelease)) {GrabQ.wakeup(); return;}
    }
    public Token(int initial tokens) {
        for (int i = 0; i < initial tokens ; i++) Release();
    }
    [OneWay] public void Release() {
        lock(mlock) {
            ReleaseQ.add();
            if (! s .match(mRelease)) {
                s .set (mRelease);
                scan (); }}
    }
    public int Grab(int id) {
        Monitor.Enter(mlock);
        if (! s .match(mGrab)) goto now;
        later :
        GrabQ.yield(mlock); if (GrabQ.empty) s.clear(mGrab);
        now:
        if (s .match(mRelease)) {
            ReleaseQ.get (); if (ReleaseQ.empty) s.clear(mRelease);
            scan();
            Monitor.Exit(mlock);
            {
                return id; // source code for the chord
            }}
        else{
            s .set (mGrab); goto later ; }}
}
```

Example (From Paper)

```
public abstract class ActiveObject {
        protected bool done;
        abstract protected void ProcessMessage();
        public ActiveObject(){
                done = false;
                mainLoop();
        }
        async mainLoop(){
                while (!done){
                        ProcessMessage();
                }
        }
}

public class StockServer:ActiveObject{
        private ArrayList clients = new ArrayList();
        public async AddClient(Client c) && override protected void ProcessMessage(){
                clients.Add(c);
        }
        public async WireQuote(Quote q) & override protected void ProcessMessage(){
                foreach(Client c in clients){
                        c.UpdateQuote(q);
                }
        }
}
```